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0.002Hz TO 3MHz

LIN/LOG SWEEP

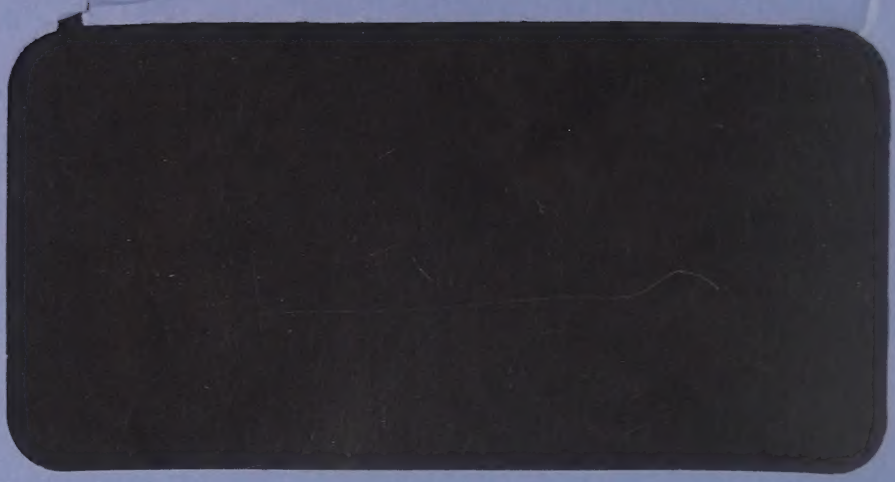
FUNCTION GENERATOR

MODEL 5300(R) SERIAL NO.____

OPERATING AND MAINTENANCE MANUAL

KROHN-HITE CORPORATION

Avon Industrial Park/Bodwell St., Avon Massachusetts 02322 U.S.A.



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580 Massachusetts Ave., Cambridge, Mass. 02139 U.S.A.

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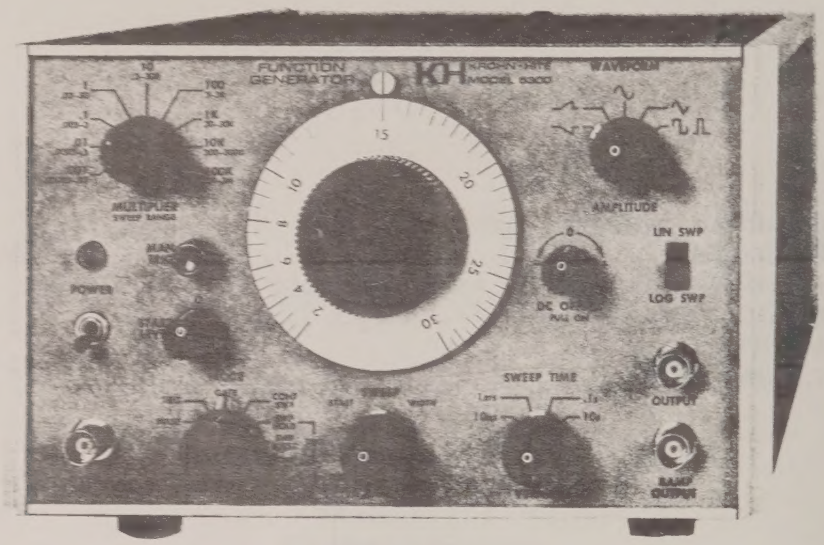
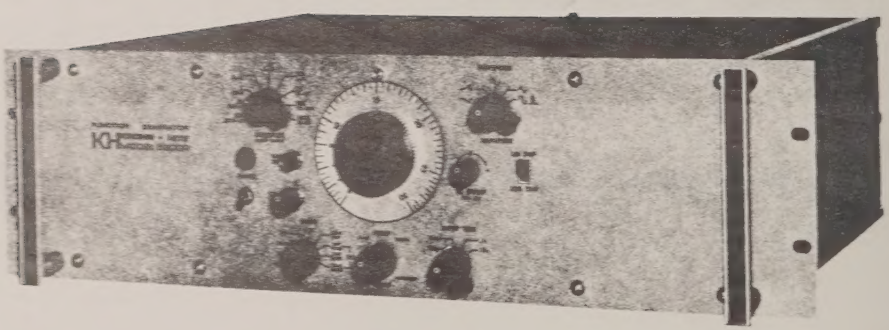


Model 5300



Model 5300R

Figure 1. Models 5300 and 5300R Function Generator

SECTION 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The Krohn-Hite Model 5300 Function Generator consists of two generators in one package: A waveform generator, which provides sine, square, triangle, positive and negative ramps over the frequency range of 0.002 Hz to 3 MHz, and a ramp generator, providing linear or exponential ramps over the frequency range of 0.1 Hz to 100 KHz. These two generators may be operated independently or may be internally connected to provide a wide variety of functions including fixed frequency bursts, frequency sweeps, or pulses. In the external and swept modes the main output frequency extends from approximately 0.00003 Hz to 3 MHz. Externally generated or internally generated signals may be used to sweep the main output frequency over a range of 1000:1. The amplitude of the main output is 20 volts p-p open circuit, 10 volts p-p across 50 ohms; ramp output amplitude is 10 volts peak open circuit, 200 ohms source impedance. The main output signal may be offset by ±5 volts open circuit by means of a front panel control. In this book, the term Model 5300 refers to both the bench model 5300 and the rack-mounted model 5300R, unless otherwise stated.

The function generator is carefully inspected, aged, and adjusted before shipment, and should be ready for operation when it is unpacked. If it appears to have been damaged in shipment, make a claim with the carrier and notify Krohn-Hite immediately.

1.2 SPECIFICATIONS*

Main Output

Waveforms: Sine, square, triangle, pos. ramp, neg. ramp, pulse.

Frequency Range: 0.002 Hz to 3 MHz with single turn dial calibrated with linear scale from 2 to 30 and 9-position multiplier. Range 0.00003 Hz to 3 MHz in external VC and sweep modes.

* Specifications apply after 30 minute warmup.

BAND	MULTIPLIER	FREQUENCY DIAL RANGE (Hz)	EXT. VC AND INTERNAL SWEEP RANGE (Hz)
1	.001	0.002 - 0.03	0.00003 - 0.03
2	.01	0.02 - 0.3	0.0003 - 0.3
3	.1	0.2 - 3	0.003 - 3
4	1	2 - 30	0.03 - 30
5	10	20 - 300	0.3 - 300
6	100	200 - 3k	3 - 3k
7	1k	2k - 30k	30 - 30k
8	10k	20k - 300k	300 - 300k
9	100k	200k - 3M	3k - 3M

Dial Accuracy: ±2% of full scale on bands 2 thru 9, ±5% of full scale on band 1.

Frequency Stability: 0.05% in 10 min., 0.25% in 24 hr., 0.01% for 10% line change, 0.025% jitter (cycle to cycle).

Time Symmetry: Square, triangle, 99% from 0.002 Hz to 100 KHz.

Ramp Duration: 47% of period. Fall time less than 30 ns.

Maximum Amplitude: Sine, square, triangle, pulse, 20V peak to peak open circuit, 10V peak to peak across 50 ohms; ramps, 10V peak open circuit, 5V peak across 50 ohms.

Impedance: Constant 50 ohms.

Amplitude Control: Single turn infinite resolution.

DC Output Drift: Less than 5 mv/^{o}C.

Sine Wave Flatness: 0.05 dB from 0.002 Hz to 100 KHz; 0.15 dB to 3 MHz.

Sine Wave Distortion: At maximum output, less than 0.5% from 0.02 Hz to 100 KHz; 1% to 0.002 Hz, 3% to 3 MHz.

DC Offset: 0 to ±5V open circuit with front panel control; maximum peak signal plus dc offset ±10V.

Triangle and Ramp Linearity: Greater than 99% from 0.002 Hz to 100 KHz; 95% to 1 MHz.

Square Wave: Rise and fall time less than 30 ns; total aberrations less than 5% with 50 ohm load.

Ramp Output (Independent of Main Output in EXT VC, CONT, TRIG, and GATE modes: internally connected in all other modes).

Waveforms: Linear ramp (sawtooth), exponential ramp, selected by LIN SWP-LOG SWP switch.

Frequency: 0.1 Hz to 100 KHz (10s to 10us) selected with three-position SWEEP TIME switch and Vernier.

Duration: Greater than 99% of period to 10 KHz (100us), 90% to 100 KHz (10us).

Ramp Amplitude: 0 to 10 volts peak, open circuit, with single turn control. In sweep modes, determines sweep bandwidth.

Ramp Offset: 0 to 10 volts dc, open circuit, with single turn control. In sweep modes, determines minimum frequqncy.

Maximum Output: 10 volts peak ramp plus dc offset. In sweep modes, main output frequency is proportional to ramp output voltage.

Impedance: Constant 200 ohms.

Auxiliary Outputs: (rear panel connectors)

Square Wave: 5V peak to peak, open circuit, 50 ohms impedance, rise and fall time less than 15 ns, aberrations less than 5% with 50 ohm matched load. Frequency coincident with main output.

Sawtooth: Greater than -10V peak, open circuit, 600 ohm impedance. Frequency coincident with ramp output.

Operational Modes (Main Output)

EXT VC: Operates as a waveform generator with frequency determined by an external voltage and multiplier setting. Frequency ratio 1000:1 with 5 mV to 5V input. Input impedance 10k ohms, response time approx. 1us.

CONT: Generator frequency determined by dial and multiplier. Frequency may be controlled ±3% about dial setting with an external voltage.

PULSE: Provides pulses in the square wave position of the Waveform switch, adjustable between 200ns and 5s with dial and multiplier, at rep rate independently set with Sweep Time controls. In sine and triangle positions, provides single cycle at sweep time rep rate.

TRIG: Applying a pulse to TRIG INPUT or pressing MAN TRIG button produces one complete cycle of dial frequency.

GATE: Output signal continues as long as level at TRIG INPUT is maintained or MAN TRIG button remains pressed.

CONT SWP: Output continues sweeping between frequencies determined by multiplier and Sweep Start and Width controls at a rate set by Sweep Time controls. Maximum frequency-sweep ratio is 1000:1.

TRIG SWP HOLD: Output provides one sweep, holding highest frequency, when pulse is applied to TRIG INPUT or MAN TRIG button is pressed.

TRIG SWP BURST: Output provides one sweep when pulse is applied to TRIG INPUT or MAN TRIG button is pressed. Final cycle will stop at start level.

TRIG TONE BURST: Output provides fixed-frequency burst when pulse is applied to TRIG INPUT or MAN TRIG button is depressed; length of burst determined by Sweep Time controls.

Sweep Characteristics

Linear or exponential for log sweep, determined by setting of LIN SWP-LOG SWP switch.

Start Level Control

Signal start level is adjustable on all triggered and gated modes; last cycle is completed to set level.

Trigger Input

Greater than 1V into 10k impedance ac coupled.

Gate Input

Greater than 1V into 10k impedance at TRIG INPUT.

Operating Ambient Temperature Range

0°C to 50°C.

Controls

Front panel: Frequency dial and Multiplier switch, Waveform switch, Amplitude control, Power switch, Manual Trigger button, Start Level control, DC Offset switch and control, Linear Sweep-Log Sweep switch, Mode switch, Sweep/Ramp controls, Sweep Time switch and Vernier.

Rear panel: Symmetry Adjust, DC Level adjust, Line switch.

Terminals (BNC Type)

Front panel on Model 5300, rear panel on Model 5300R: Trigger Input, Main Output, Ramp Output.

Rear panel - all models: VC Input, Aux. Square wave, Aux. Sawtooth.

Power

105-125 or 210-250 V single phase 50-400 Hz 45 watts.

Dimensions and Weights

Bench Model 5300: 8 5/8" wide, 5 1/4" high, 14 1/2" long; 12 lb/8 kg net, 15 lb/9 kg shipping. Rack Model 5300R: 19" wide, 5 1/4" high, 15 1/2" deep; 16 lb/8 kg net, 20 lb/10 kg shipping.

SECTION 2
OPERATION

2.1 POWER REQUIREMENTS

The Model 5300 Function Generator may be used either with a 105-125 volt, 50-400 Hz line or with a 210-250 volt, 50-400 Hz line. The line voltage can be selected by operation of the Line switch on the rear panel. All units will be shipped with the Line switch in the 115 volt position and a fuse bag attached to the line cord. The fuse bag will contain a 0.25 ampere fuse. When 230 volt operation is required, replace the 0.5 ampere fuse with the 0.25 ampere fuse and switch the Line switch to the 230 volt position.

2.2 OPERATING CONTROLS AND CONNECTORS

2.2.1 Front Panel Controls

POWER: on-off switch and pilot light.

FREQUENCY DIAL AND MULTIPLIER: single turn dial with 5 to 1 vernier drive, graduated 2 to 30 for continuous control of frequency, with a 9 position multiplier switch, X.001 to X100K in decades. Multiplier positions are also marked with approximate frequency range for each position when generator is in EXT VC and sweep modes.

WAVEFORM: 5 position switch for selecting negative ramp, positive ramp, sine, triangle or square wave. When this switch is in the square wave position, and the MODE switch is in the PULSE position, the main output provides pulses; pulse width is adjustable by means of the frequency dial and multiplier, while pulse repetition rate is adjustable by means of the SWEEP TIME control.

AMPLITUDE: Single turn control for adjusting the amplitude of the Main output waveform. Minimum output is less than 100 millivolts.

MAN TRIG: In TRIG modes, pressing button provides one cycle of waveform, one pulse, one sweep or one burst. The GATE mode provides a signal at the main output as long as the button is pressed, plus the time necessary to complete the cycle.

START LEVEL: Single-turn control; used for adjusting pick off point to greater than ±70 degrees for the start of the sine or triangle signal. In the PULSE, TRIG, GATE and BURST modes, the sine or triangle signal starts and the final cycle ends at the level set by the START LEVEL control. This control has no effect

in the square wave position. In the PULSE mode, with the sine waveform, adjustment of this control to maximum CCW will produce a haversine waveform.. This control has no effect on the positive ramp and it distorts the negative ramp.

DC OFFSET: Push-pull switched potentiometer; determines the dc offset of the output signal by up to ±5 volts, open circuit. The dc offset, plus the ac signal, should not exceed 10 volts peak open circuit, or clipping will occur.

LIN SWP-LOG SWP: Two-position switch for selecting linear or exponential (logarithmic) ramp slope characteristics. For internal sweep modes, it determines whether the frequency sweep will be linear or exponential. When switching from one position to the other, the set ramp output levels and sweep start and width are not maintained.

MODE: Nine-position switch for selecting the operating mode. Modes are described in detail in the specifications and in paragraph 2.2.2.

SWEEP-RAMP: Concentric single-turn controls used for setting the dc offset and amplitude of the ramp output. They also control the sweep start point and sweep width. For this reason they are labeled to accommodate both functions. The inner (gray) knob sets the dc level (offset) of the ramp and the outer (red knob sets the amplitude of the ramp. The dc level and the amplitude are adjustable from 0 to 10 volts. The maximum ramp output however, will not exceed 10 volts. There is interaction between these controls. The dc level setting is not effected by the amplitude setting, but the dc level setting has a significant effect on the amplitude setting. If the amplitude is at maximum and the dc level is increased, the amplitude will be reduced by the amount of the dc increase, maintaining its peak level. A recommended procedure for minimizing interaction is to always set the START-OFFSET (gray) knob first and then the WIDTH-AMPLITUDE (red) knob. In the sweep modes, the START (gray) knob determines the lower frequency and the WIDTH (red) knob determines the upper frequency limit.

The ramp output voltage is directly related to the sweep frequency. The output frequency is approximately 3 Hz per volt, times the multiplier setting. In the PULSE, GATE, CONT SWP, TRIG SWP HOLD, TRIG SWP BURST and TRIG TONE BURST, the ramp generator is internally connected to the main generator. The SWEEP-RAMP controls set the ramp output levels and only effects the sweep start and stop frequencies. The levels set by these controls are not maintained when switching from linear to exponential.

SWEEP TIME: Three-position switch and vernier is used to set the ramp rep rate, the rep rate in the PULSE mode and the swept and tone burst width in the TRIG SWP BURST and TRIG TONE BURST mode. The three ranges are: 10us-1ms, 1ms-0.1s and 0.1s-10s.

2.2.2 Mode Operation

The position of the MODE switch determines the way in which the frequency of the main output is controlled, and the relationship between the ramp and the main generator outputs. The frequency range of the main output in all modes is determined by the multiplier switch. In the EXT VC mode, this range is approximately

1000:1 and controlled by an externally supplied voltage; the range in the sweep modes is also about 1000:1. In the PULSE mode, pulse width is controlled by the dial and multiplier. In the TRIG, GATE and TONE BURST modes, frequency is determined by the dial and multiplier. In the sweep modes, the dial is removed from the circuit, and the frequency is controlled by the internal ramp. In the PULSE mode, the repetition rate of the pulse at the main output is determined by the repetition rate of the ramp; in the TRIG TONE BURST and TRIG SWP BURST mode, the length of the burst is determined by the period of the ramp. The various modes are described in detail below.

EXT VC MODE

With the MODE switch in the EXT VC position, a positive voltage applied to the VC INPUT can be used to control main output frequency to a ratio of approximately 1000:1. A 5-volt level will provide the maximum output frequency normally obtainable for a given multiplier setting. The relationship between voltage and frequency is:

Frequency = 6 X External Voltage X Multiplier

That is, with the multiplier in the X1K position, 0.005 volts gives 30 Hz, 0.05 volts gives 300 Hz, 0.5 volt gives 3 KHz. Notice that with the multiplier in the X.001 position, 5 millivolts gives 0.00003 Hz, well below the dial range. The frequency accuracy is approximately 3 percent from 5 volts to 100 millivolts. Frequency linearity, however, is within 0.5 percent over the entire 1000:1 range. Maximum accuracy is obtained when all internal dc levels have been optimized, particularly at low VC voltages. At low VC voltages also, distortion can be minimized by adjustment of the SYM ADJ control on the rear panel. Oscillation will stop when a negative voltage of greater than 0.1 volts is applied to the VC input. However, ±30 volts can be applied to the VC input without damage to circuitry.

When the generator is in the GATE, CONT and TRIG TONE BURST modes, an external voltage can be used to frequency-modulate the output frequency. The frequency can be varied by ±3 percent about the dial-indicated frequency by the application of ±5 volts at the VC INPUT connector. The percent modulation is proportional to the modulating voltage.

When the EXT VC mode is in use, the ramp generator free-runs, controlled by the SWEEP - RAMP and SWEEP TIME controls.

CONTINUOUS MODE

When the generator is in the CONT mode, the signal at the main output is the waveform selected, at the frequency determined by the frequency dial and the multiplier switch. The main output frequency equals the dial reading times the multiplier. In this mode, the ramp output is independent of the main output.

PULSE MODE

In the PULSE mode, with the WAVEFORM switch in the square wave pulse position, the main output will produce pulses. The rep rate must be twice the pulse width

or longer. The rep rate is determined by the SWEEP TIME controls. The pulse width is determined by the setting of the frequency dial and the multiplier as follows:

$$\text{Pulse Width in Seconds} = \frac{1}{2 \times \text{Dial} \times \text{Multiplier}}$$

For example, with the frequency set at 20 KHz, the pulse width will be 25 microseconds.

The pulse has a negative base line and is symmetrical about ground. At the 5 volt square wave output on the rear panel, the pulse will be inverted. For waveforms other than square wave, the main output will produce one cycle of the selected waveform at the rep rate set by the SWEEP TIME controls. With the sine and triangle, the pickoff point between cycles can be adjusted by means of the START LEVEL control; this control has no effect on the positive ramp, and with the negative ramp produces a distorted waveform. A haversine waveform can be generated by using the sine waveform, and adjusting the START LEVEL control to shift the pick off point to its negative limit.

TRIG MODE

A trigger pulse of 1 volt or greater, with a rise time of less than 500ns, applied to the TRIG input, provides a single waveform at the main output. The wave shape is determined by the WAVEFORM switch, and the duration by the dial and the multiplier setting. A single waveform can also be generated by pressing the MAN TRIG button on the front panel. The trigger rep rate must always be longer than the time for one complete cycle at the main output. In the TRIG mode, the ramp output is independent of the main output.

GATE MODE

In the GATE mode, applying a level to the TRIG INPUT or holding the MAN TRIG button depressed, will produce a fixed frequency signal at the main output. The frequency of the signal is determined by the setting of the frequency dial and multiplier. It will remain on as long as the gate is applied. The GATE input voltage must be greater than 1 volt to initiate an oscillation at the main output. The level required to maintain or stop an oscillation may be less than that required to start it.

The ramp output is independent of the main output in this mode and may be used to gate the main output with an external connection. On the sine and triangle waveforms, the pickoff level between gated bursts is set by means of the START LEVEL control.

SWEEP MODES AND TONE BURST MODE

In the sweep modes, the ramp is internally connected to the frequency control network of the main generator, and the main output is swept over a band whose width is determined by the SWEEP-RAMP controls, for a length of time determined by the SWEEP TIME controls. Since the SWEEP-RAMP controls set the ramp dc level and amplitude, they also set the limits of the frequency band swept in the

sweep modes. The start, or low frequency limit of the frequency sweep, is adjusted by means of the SWEEP START control (gray knob), while the upper frequency limit is adjusted by means of the SWEEP WIDTH control (red knob). The maximum approximate sweep range is marked on each multiplier position; its ratio is 1000:1, with the frequency limits determined by the multiplier. In the sweep modes, the multiplier should be set to the lowest range that will give the highest frequency desired. That is, for a maximum frequency of 20 KHz, use the X1K multiplier rather than the X10K multiplier. For wide sweep ranges, adjustment of the low-end frequency may be critical; in Step 3 below when the start frequency is adjusted, it may be necessary to adjust the SYM ADJ potentiometer on the rear panel for maximum symmetry.

In all three sweep modes, the ramp output is directly proportional to the main output frequency, and so can be used for a related function, such as X-Y plotting. The ramp output in the TRIG SWP HOLD, TRIG SWP BURST, and TRIG TONE BURST modes is the same; i.e., the ramp holds its maximum level until the next cycle (sweep) is triggered, even though the frequency at the main output is handled differently in each case.

In the continuous sweep mode, the ramp sweeps the output frequency continuously, while in the triggered sweep and hold mode, the ramp provides one complete sweep of the output frequency holding the maximum frequency until reset by the trigger.

In the TRIG SWP BURST mode, the ramp sweeps the output frequency until it reaches its maximum preset amplitude. The ramp will hold this level and the main output signal will turn off after completing its final cycle, stopping at the level set by the START LEVEL control. In the TRIG TONE BURST mode, the ramp retrace is used to turn off the main generator providing a fixed frequency burst when triggered by a pulse at the TRIG Input. The length of the burst in both burst modes is determined by the SWEEP TIME controls.

Suggested method of setting a desired frequency sweep range is as follows:

(1) Set the MODE switch to the TRIG SWP HOLD position. In this position, the main output holds at the highest frequency.

(2) Rotate the SWEEP WIDTH control (red knob) full counterclockwise (min sweep width).

(3) Adjust the SWEEP START control (gray knob) for the minimum desired frequency, as measured at the main output.

(4) Adjust the SWEEP WIDTH control (red knob) for the maximum frequency desired. Since the highest frequency is held, the output frequency will follow this control setting.

(5) Set the MODE switch to the sweep mode required.

2.2.3 Auxiliary Sawtooth Output

The auxiliary sawtooth output, on the rear panel, is coincident with the ramp output, but opposite in polarity; between triggered sweeps, it maintains a greater than -10 volt level. The auxiliary sawtooth is fixed in amplitude, always linear and is not an analog of the main output frequency for the log sweep.

2.2.4 Auxiliary Square Wave Output

The auxiliary square wave output, on the rear panel, is a fixed 5 volt square wave. Its phase is inverted with regard to the main output square wave.

2.2.5 Exponential Ramp Characteristics

When the ramp characteristic is exponential, the offset is minimum and the amplitude is maximum, the ramp generated is from close to zero to approximately 10 volts. When the sweep range is reduced, by increasing the lowest frequency, the ramp becomes smaller. The smaller the segment becomes, the less exponential the ramp appears. At the extreme, a narrow sweep around the 10 volt level, it is difficult to see the difference between the exponential and linear ramp.

2.2.6 Rear Panel Controls

LINE--Two-position switch for selection of 115 or 230 volt operation.

SYM ADJ--Ten-turn potentiometer for periodic adjustment of waveform symmetry.

DC OUTPUT LEVEL--Ten-turn potentiometer for period adjustment of dc output level.

2.2.7 Connectors

2.2.7.1 Front Panel on Model 5300, Rear Panel on Model 5300R

TRIG INPUT--In all TRIG modes, a 1-volt or greater pulse applied to this connector will provide one cycle, one sweep, or one burst at the main output.

In the TRIG SWP HOLD, TRIG SWP BURST, and TRIG TONE BURST modes, a 1-volt or greater pulse will provide one ramp (holding maximum voltage until the next trigger) at the ramp output. In the GATE mode, a 1-volt, or greater, dc level at this input will provide a fixed-frequency signal at the main output as long as the level is maintained. In the GATE mode, the 1 volt dc level required to start the main output signal is higher than that required to maintain the signal. Impedance of the TRIG INPUT is 10K ohms. One hundred volts may be applied in the TRIG INPUT without damage to circuitry.

OUTPUT--The selected waveform appears at this connector. The specific mode of operation is dependent upon the position of the MODE switch. Impedance is 50 ohms.

RAMP OUTPUT--The ramp signal is obtained at this connector. Its characteristics determined by the SWEEP-RAMP, SWEEP TIME, and LIN SWP-LOG SWP

controls. In the EXT VC, CONT, TRIG, and GATE modes, the ramp signal is completely independent of the main output and may be used for an unrelated purpose, provided the grounds are common. In the PULSE and TRIG TONE BURST modes, the ramp retrace is used for the timing of the main output and the ramp is available at the RAMP OUTPUT. In the sweep modes, the ramp output voltage is an analog of the main output frequency. Impedance is 200 ohms.

2.2.7.2 Rear Panel, All Models

5 VOLT ⌐⌊ --Fixed amplitude 5-volt square wave, frequency coincident with main output. Impedance is 50 ohms.

-10V ⟍ -- Fixed amplitude, greater than -10 volt sawtooth, frequency coincident with ramp output. Impedance is 600 ohms.

VC INPUT--Input for external voltage control of main output. This input is normally used only in the EXT VC and CONT modes; however, since it is connected to the frequency control network in all modes, it may be useful in more complex applications. Impedance is 10K ohms.

SECTION 3
INCOMING INSPECTION AND CHECKOUT

3.1 INTRODUCTION

The following procedure should be used to verify that the generator is operating within specifications, both for incoming inspection and for routine servicing. Tests must be made with all covers in place and the procedure given below should be followed in sequence. Follow the operating procedures given in Section 2.

3.2 EQUIPMENT REQUIRED

(a) Oscilloscope having direct coupled horizontal and vertical amplifier with 10mv/cm sensitivity and bandwidth of at least 30 MHz, Tektronix Type 545 or equal with 1A5 plug-in unit.

(b) Frequency counter capable of measuring 0.01 Hz to 3 MHz.

(c) AC voltmeter, Ballantine Type 323 or equal (± 2% to 5 MHz).

(d) Calibrated voltage source, or regulated DC supply and digital voltmeter 0 to 10 volts.

(e) Distortion meter, Hewlett Packard Type 333A.

3.3 PROCEDURE

After allowing the instrument to warm up for 30 minutes, set the controls to the following positions:

FREQUENCY DIAL AND MULTIPLIER	30 X100
MODE	CONT
AMPLITUDE	Max. CW
WAVEFORM	Sine
DC OFFSET	Off
SWEEP TIME	1ms-.1s, vernier Max. CCW
RAMP OFFSET	Max. CCW
RAMP AMPLITUDE	Max. CW
LIN SWP-LOG SWP	LIN SWP

3.3.1 Waveforms

Connect the output of the generator to the oscilloscope with a 50 ohm load, terminated at the oscilloscope. Rotate the WAVEFORM switch through all positions to check for the presence of all waveforms. Return the switch to the sine position.

3.3.2 Amplitude Control

With the WAVEFORM switch to sine, rotate the amplitude control to the max. CCW end; the signal amplitude should diminish by more than 60 dB. Rotate the amplitude control to the max. CW end and remove the 50 ohm load across the output of the generator. The voltage should increase to greater than 20 volts peak to peak.

3.3.3 DC Offset

Operate the DC OFFSET control with amplitude control CCW; control should be capable of offsetting signal by ±5 volts open circuit when control is pulled on. Push the offset control off.

3.3.4 DC Level

Connect a dc voltmeter to the output of the generator. Rotate the Amplitude control to the max. CCW end. It should be possible to set the level to zero by means of the DC OUTPUT LEVEL potentiometer on the rear panel. Rotate the Amplitude control to the max. CW end.

3.3.5 Frequency Accuracy

Connect the frequency counter to the generator output. Check the frequency with the dial at 2, 15 and 30 in all frequency bands. Frequency should be within 2 percent of full scale on bands 2 thru 9, 5 percent of full scale on band 1.

3.3.6 Sine Distortion

With the WAVEFORM switch on sine, and the frequency set to 2 X1K, check the sine distortion using the distortion meter. Adjust symmetry control on the rear panel for a distortion reading of less than 0.5 percent.

3.3.7 External Frequency Control

With the frequency set to 10 X1K, connect the calibrated voltage source to the VC INPUT. Vary the VC voltage ±5 volts; the output frequency should change to approximately ±3%. Place the MODE switch in the EXT VC position. Apply 5 volts to the VC INPUT; the output frequency should be approximately 30 KHz (±3%). Apply 5 millivolts to the VC INPUT; the frequency should be 30 Hz (±10 Hz). Disconnect the VC INPUT and set the MODE switch to CONT.

3.3.8 Ramp Amplitude and Offset

Connect the oscilloscope to the RAMP OUTPUT. Ramp amplitude should be at least 10 volts. Connect a 200 ohm load across the ramp output, voltage should

drop to 5 volts (6dB). Remove 200 ohm load. Turn the RAMP AMPLITUDE control (red knob) to the max. CCW end. Amplitude should drop to zero. Turn the RAMP OFFSET control (gray knob) to the max. CW end. Level should rise to at least 10 volts. Return RAMP OFFSET to the max. CCW end and RAMP AMPLITUDE to the max. CW end.

3.3.9 Ramp Waveform

Change the LIN SWP-LOG SWP switch to LOG SWP. The ramp waveform should be exponential.

3.3.10 Sweep Time Controls and Pulse Mode

With the MODE switch on PULSE, the Waveform switch on Square Wave, the frequency set to 20 X10K, connect the frequency counter to the main output and check the ramp frequency ranges, by measuring the pulse repetition rate. With the SWEEP TIME switch in each position, count pulse frequency with the vernier in the CW and CCW positions. Frequencies should cover the range indicated, with some overlapping between switch positions.

3.3.11 Trig Mode

Set the SWEEP TIME control to the .1s-10s position, vernier control to the max. CW end. Set the Waveform switch to the Sine Wave position. Set the MODE switch to TRIG and the frequency to 20 X100. The Main output should produce one cycle for each time the MAN TRIG button is pressed.

3.3.12 Gate Mode

Set the Mode switch to GATE. Press the MAN TRIG button. Output signal should be maintained as long as button is depressed. Apply a 1-volt level to the TRIG INPUT. Output signal should be maintained as long as level is applied.

3.3.13 Cont SWP Mode

Set the MODE Switch to CONT SWP. Output frequency should sweep continuously at a rate set by the sweep time controls. The ramp should be present at the RAMP OUTPUT. It may be easier to observe the frequency sweeping at a low sweep rate.

3.3.14 Trig SWP Hold Mode

Switch to TRIG SWP HOLD and trigger with MAN TRIG button. Output frequency should sweep, holding highest frequency until triggered again.

3.3.15 Trig SWP Burst Mode

Switch to TRIG SWP BURST and trigger with MAN TRIG button. Main output frequency should sweep to maximum and then assume a dc level, determined by the START LEVEL control.

3.3.16 Trig Tone Burst Mode

Switch to TRIG TONE BURST and trigger with MAN TRIG button. Main output should be fixed frequency, determined by frequency dial, produced for a length of time determined by the setting of the SWEEP TIME controls.

3.3.17 Start Level

Set the SWEEP TIME control to the 1ms-.1s position, vernier control to the max. CCW end. Set the MODE switch to the PULSE position. Adjust the START LEVEL control to change the level to the maximum negative peak of the sine wave, forming a haversine function.

3.3.18 Auxiliary Sawtooth

Connect the oscilloscope, to the auxiliary sawtooth connector on the rear panel. Sawtooth should be linear with a peak amplitude of at least -10 volts.

3.3.19 Auxiliary Square Wave

Connect the oscilloscope and 50 ohm load to the auxiliary square wave output. The amplitude should be at least 2.5 volts peak to peak.

SECTION 4
CIRCUIT DESCRIPTION

4.1 GENERAL

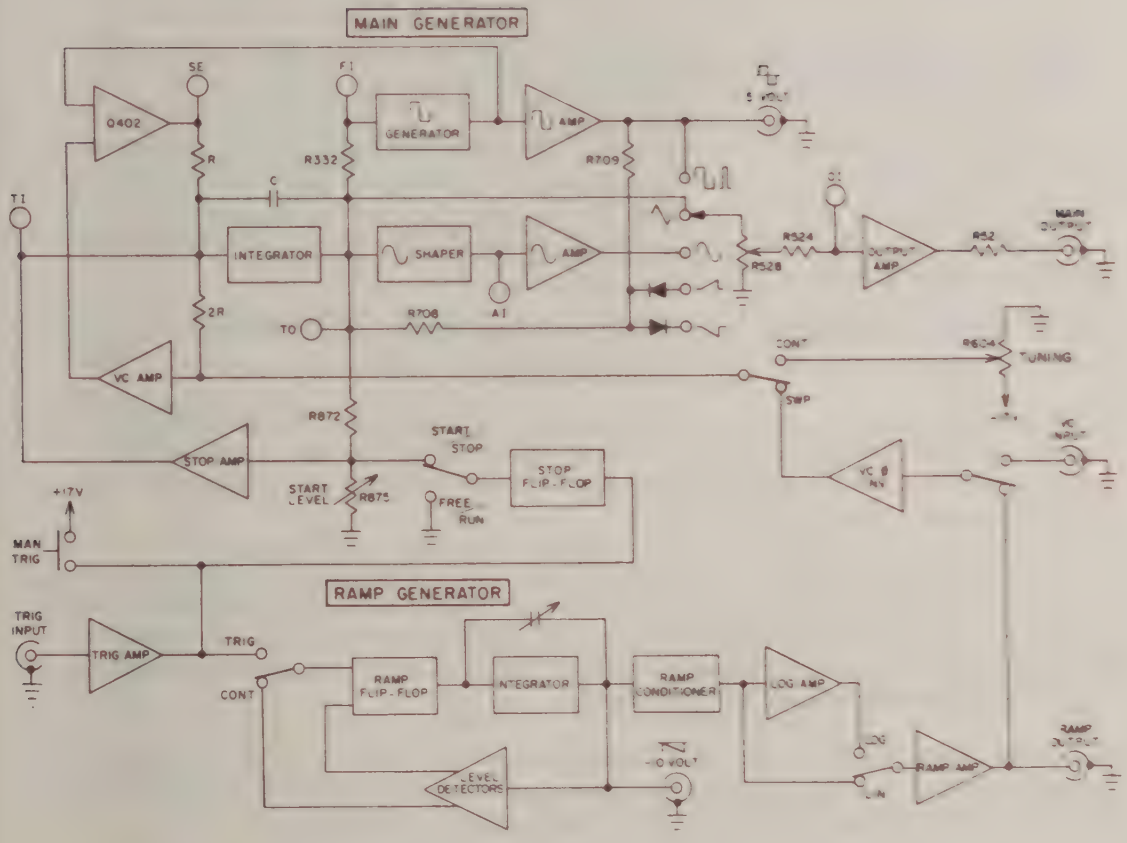


Figure 2. Simplified Schematic Diagram

The model 5300 consists of two waveform generators and a regulated power supply. The main waveform generator incorporates a square wave generator, a triangle generator and a sine shaper. The second generator produces ramps and is interconnected to the main generator through control circuitry. A simplified schematic diagram of the generator is shown in Figure 2.

In addition to frequency control of the main generator by the ramp generator, start-stop circuitry is incorporated to inhibit operation of the main generator.

The desired performance is accomplished by interconnecting the generators with the MODE selector switch. This switch, in each position, determines how the main generator frequency is controlled, how the start-stop circuit is activated and how the sweep reset path in the ramp generator is completed.

The Modes of operation are determined in the following manner:

EXT VC--The stop-start circuit is inoperative. Frequency control of the main generator is taken from an external source. The ramp generator free runs.

CONT--The stop-start circuit is inoperative. Main generator frequency is controlled by the frequency dial. The ramp generator free runs.

PULSE--The stop-start circuit is used. The retrace from the ramp generator turns off the stop-start circuit, permitting the main generator to start operation. However, the positive going edge of the square wave resets the stop flip flop allowing the stop-start circuit to turn on at the end of one cycle of the triangle, inhibiting the main generator.

TRIG--Similar to PULSE, except the initiating pulse comes from the manual or external trigger circuit. The ramp generator free runs.

GATE--The stop-start circuit is energized. A level from the MAN TRIG push-button or TRIG INPUT turns off the stop-start circuit for the length of time the level is applied. Main output frequency is determined by the tuning dial. The ramp generator free runs.

CONT SWP--The stop-start circuit is turned off. The ramp generator free runs at a rate determined by the SWEEP TIME controls, slope and amplitude, determined by LIN SWP-LOG SWP switch and SWEEP-RAMP control respectively. Ramp is applied to the frequency control circuit of the main generator and the tuning dial is switched out of the circuit.

TRIG SWP HOLD--Same as CONT SWP, except the reset loop of ramp generator is interrupted, preventing the ramp generator from free-running. Ramp output remains at maximum until reset by a manual or external trigger.

TRIG SWP BURST--The stop-start circuit is activated; an external trigger resets the ramp and a level from the ramp output turns off the start-stop circuit and holds it off while the ramp sweeps the frequency. At the end of the sweep, the ramp holds its maximum level, and the stop-start circuit is turned on, inhibiting oscillation of the main generator.

TRIG TONE BURST--Same as TRIG SWP BURST, except that the dial is connected to the main generator, controlling the burst frequency.

4.2 MAIN GENERATOR (See Figure 2)

The main generator oscillating system is comprised of the square wave generator and the integrator, with frequency controlled by the frequency dial and the VC amplifier. This system generates square and triangle waves, which are further processed to form the sine and ramp functions. The frequency control dial or the VC input sets a negative voltage, which is applied to the 2R resistive network, setting a negative level at the input to the integrator, and charging the integrator feedback capacitor C. The integrator capacitor C, is one of the multiplier bandswitch capacitors. This negative level also determines the VC amplifier output level, which is applied to the collector of gate Q332. When Q332 is turned on by the square wave generator, it drives the R resistive network, and the integrator charges the feedback capacitor in the opposite direction. When the square wave shuts off gate Q332, the cycle repeats.

The output of the integrator is a triangle, which is used as the triangle function, as the input to the sine shaper, and regeneratively as the trigger for the square wave generator. The square wave generator output is used to provide both the main and auxiliary square wave outputs.

The sine and square waves are fed through amplifiers to the WAVEFORM switch. The triangle is fed directly to the switch and also through a summing network, where it is added to the square wave and clipped to provide the positive and negative ramps. The output amplifier inverts its input and provides a 50 ohm output to the attenuator.

4.2.1 VC Amplifier (See Figure 3)

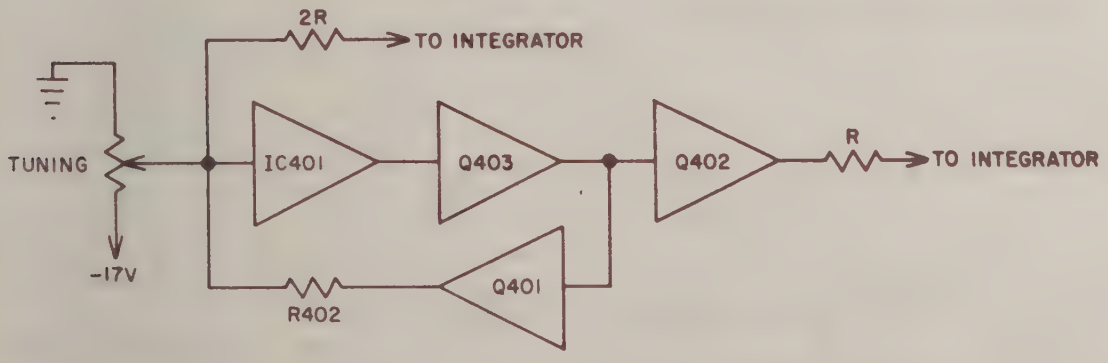


Figure 3. VC Amplifier

The VC amplifier has a gain of -1 and so inverts the voltage set by the tuning potentiometer.

The level established by the tuning potentiometer drives the 2R resistors, while the output of the VC amplifier drives the R resistors through gate Q402. When the VC amplifier is gated on, twice as much current will be provided to the integrator input as is provided by the tuning potentiometer, reversing the charge on the integrating capacitor.

4.2.2 Integrator (See Figure 4)

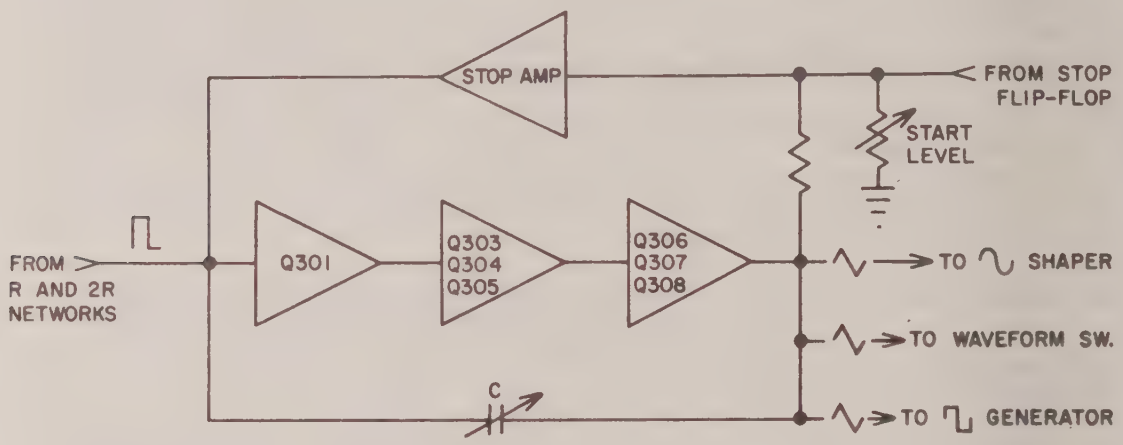


Figure 4. Integrator

The integrator is a negative "infinite-gain" amplifier with a feedback capacitor C to provide the integrating function. Two regenerative stages, Q301B-Q304 and Q307-Q308 provide the gain. Capacitor C is selected by the bandswitch. When the stop-start circuit is on, the stop amplifier provides a negative feedback around the integrator, preventing oscillation.

4.2.3 Square Wave Generator (See Figure 5)

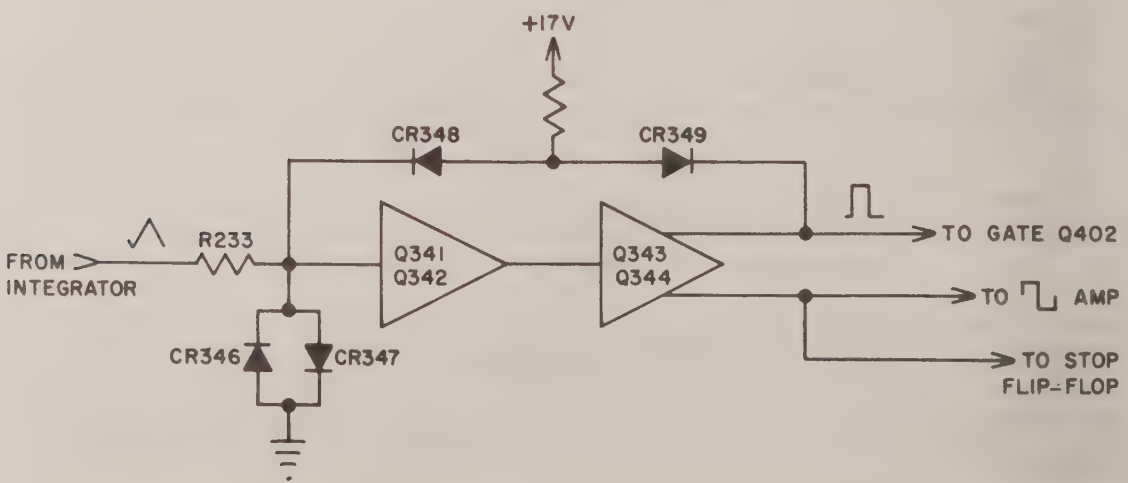


Figure 5. Square Wave Generator

The triangle, taken from the output of the integrator, triggers the square wave generator. Q341 and Q342 are a differential pair, and Q343 and Q344 are a differential pair. Q342 and Q343 form a regenerative sense amplifier with a feedback path from the collector of Q343 to the base of Q342. When the peak of the triangle reaches -10 volts, Q342 conducts, turning on Q343. As the triangle voltage goes from -10 to +10 volts, the voltage at the base of Q342 is clamped to about -0.6 volt by diode CR346. When the triangle reaches its positive peak of +10 volts, the base of Q342 goes positive turning off Q342 and turning on Q343. The voltage at the base of Q342 is limited to +.6V this time by the action of CR347. When the triangle again reaches -10 volts, the cycle repeats. The square wave from Q343 is applied to gate Q402. The square wave from Q344 drives the square wave amplifier and is used to reset the stop flip flop.

4.2.4 Square Wave Amplifier (See Figure 6)

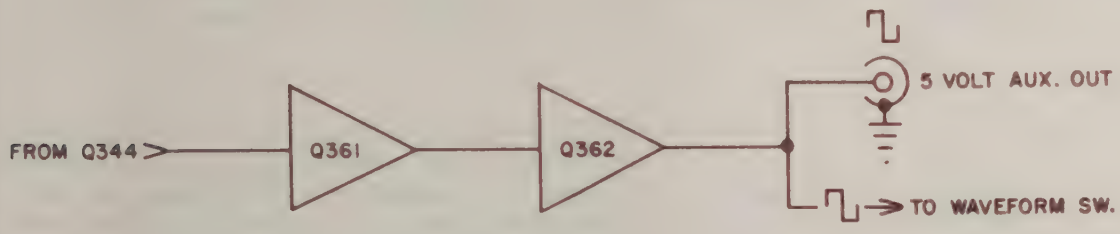


Figure 6. Square Wave Amplifier

The Square wave developed at the collector of Q344 is applied to the base of Q361, which in turn drives the base of Q362. The square wave is taken from the emitter of Q362, while the auxiliary square wave goes through R368 to its output connector.

4.2.5 Sine Shaper and Sine Amplifier (See Figure 7)

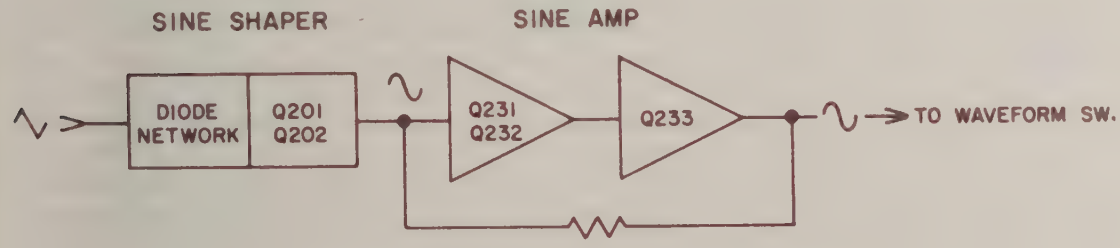


Figure 7. Sine Shaper and Sine Amplifier

The sine shaper consists of six pairs of diodes, each pair associated with a voltage divider. The function of the voltage divider is twofold: (1) it changes the slope of the input signal, and (2) it sets the level at which the diodes clip the signal. Thus when the triangle is applied to the circuit, the divider resistance changes its slope and the diodes clip it at six discrete increments within each 90 degrees. The resultant approximates a sine wave. The main purpose of Q201-Q202 is to provide the dc voltages with which the diodes clip. The thermal drift of Q201

and Q202 also cancels the thermal drift of the diodes. Potentiometers R221 and R229 are adjusted to minimize distortion. The output of the sine shaper is applied to the sine amplifier and through Q233 to the function switch.

4.2.6 Ramp Functions

The ramp functions are developed at the function switch. The square wave and the triangle are added together at resistors R708 and R709. The sum is clipped by diodes CR701 and CR702, and the resultant is applied to the output amplifier.

4.2.7 Output Amplifier (See Figure 8)

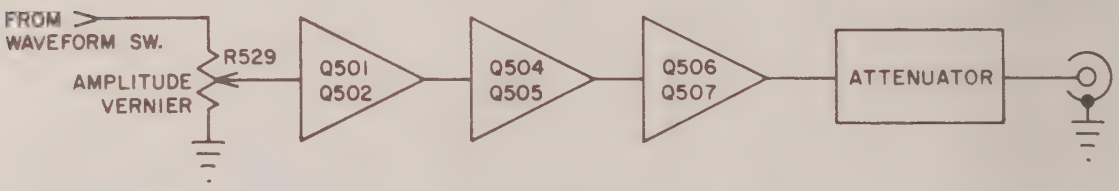


Figure 8. Output Amplifier

The output amplifier consists of a balanced input amplifier Q501-Q502, a second stage Q504-Q505, and output stage Q506-Q507. The input signal is applied to the base of Q502. The collector of Q501 drives Q505 which in turn drives output transistors Q506 and Q507. At low frequencies, Q504 is used as a constant current source, allowing for maximum voltage swing of the output transistors. At higher frequencies, additional drive signal is provided to Q504 through Q509. The input signal level is controlled by amplitude vernier R529.

4.3 RAMP GENERATOR

The basic regenerative system of the ramp generator (shown in Figure 2) is a sawtooth generator consisting of a flip-flop, an integrator and two level detectors. At the beginning of the sweep cycle, the output of the FF (Flip Flop), IC880, is sufficiently negative to turn off Q883, reverse biasing CR883 and disconnecting the integrator input. This allows the output of the integrator to increase in voltage, in a negative direction, at a rate determined by the integrating capacitor and resistor. When the output reaches approximately -12 volts, the level detector, Q884 and Q885, trigger FF, IC880, which turns on Q883, discharging the integrator capacitor rapidly through CR883 and the low impedance path of Q883. When the output of the integrator reaches 0 volts, level detector Q880 and Q881 is turned on, resetting FF, IC880, turning off Q883 and starting the cycle over again.

In the triggered sweep and burst modes, the -12 volt detector is not used to set FF, IC880, but does drive Q882, which operates the stop flip flop inhibiting the main generator. The ramp output voltage is held at -12 volts by the action of CR884 until the MAN TRIG is pressed or an external trigger is applied setting the Ramp flip-flop.

4.3.1 Ramp Flip-Flop

The Ramp flip-flop, IC880, and its output stage, Q883, switch the integrator to generate the sawtooth. At the start of the sweep, the flip flop is in the set condition, with a slightly negative output. The output of Q883 is positive, keeping CR883 open and the integrator charging the integrating capacitor (C887, C888, or C889) through R909 and R911. When the flip-flop is reset, its output goes positive, turning on Q883 and permitting CR883 to conduct, discharging the integrating capacitor through Q883. The time constant of the discharge path is much less than that of the charging path, and so the discharge is quite rapid.

4.3.2 Integrator

The integrator, consisting of Q886, Q887, Q888, and Q889 is a high gain amplifier, with the integrating capacitor providing negative feedback. The common emitter arrangement of Q887 with Q888, provides temperature compensation. Q890 prevents overshoot of the flyback sweep in the 10us-1ms range. The output of the integrator is taken from the emitter of Q889.

4.3.3 Ramp Level Detectors

The output of the integrator goes from 0 to -12 volts; these limits are maintained by the action of Q884, Q885, Q880 and Q881. Q885 is on while the ramp is negative going, the level at its base determined by voltage divider R905-R906. When the ramp reaches the same level, CR887 conducts turning on Q884 and turning off Q885 and applying a positive pulse to Pin 1 of IC880. The same pulse turns on hold gate Q882. When the voltage at the output of the integrator reaches zero, CR886 conducts, turning on Q881 and applying a pulse to Pin 3 of IC880. Diode connected Q880, provides temperature compensation for Q881. In the triggered sweep modes, sweep FF is not triggered by the minus level detector. The trigger is from the MAN TRIG or the TRIG INPUT through Q850.

4.4 STOP-START CIRCUIT

The stop-start circuit consists of flip-flop, IC850, and an amplifier, Q841 and Q842, and associated components. The flip-flop is a bistable type whose output is used to control the stop amplifier. The stop amplifier, when on, provides negative feedback around the integrator of the main generator. When the generator is in a triggered mode, for instance, the stop amplifier is initially on, inhibiting oscillation. When a trigger is applied, a positive pulse from Q850 triggers flip-flop, IC850, turning off the stop amplifier, which in turn allows the integrator to operate, permitting the main generator to start oscillating. However, the positive-going edge of the square wave from the main generator is feed back to Pin 3 of IC850, and the flip-flop changes state. The stop amplifier does not operate until the summing level at the junction CR957 and CR860 is slightly positive. In this manner, the output level of the integrator can be determined with the START LEVEL control. The action of the stop-start circuit in the other modes is as follows:

In CONT, EXT VC, CONT SWP, and TRIG SWP HOLD, the stop-start circuit is not used and its output is held off. In the PULSE mode, the start flip-flop set input is triggered by the retrace from the ramp amplifier, and is reset by the

positive going edge of the pulse allowing one cycle or pulse at the ramp rep-rate. In the gated mode, the reset input is held at a high level by trigger amplifier Q850, holding off the stop amplifier and allowing the main generator to operate. In the TRIG SWP BURST mode the stop flip-flop is controlled by Q882.

4.5 AMPLITUDE AND OFFSET CONTROLS

The Ramp Generator output is fed to circuitry consisting of Q940, Q941 and Q942. Amplitude-Width control is provided by R930A and applied to the base of emitter follower Q940. The low impedance output of Q940 drives one end of the Offset-Start control R930B. Q942 is an emitter follower to supply the other end of R930B with the proper dc level at a low impedance. The signal and level from R930B is applied to the base of emitter follower Q941. The output of Q941 drives the Log amplifier and goes to the Lin-Log switch. Q940 and Q941 are clamped together for temperature compensations. As the dc level at the base of Q941 is made more negative, by turning R930B clockwise, the ramp signal is attenuated to prevent clipping.

4.6 LOG AMPLIFIER

The Log amplifier consists of a two stage feedback amplifier, Q944 and Q943, providing a low impedance driving source to transistor Q945. The biasing of Q945, with both collector and base maintained at zero volts, takes advantage of the transconductance characteristic of the transistor to provide an exponential current source to the input of the Ramp output amplifier. Q944 and Q945 are clamped together for temperature compensation.

4.7 RAMP OUTPUT AMPLIFIER AND PHASE INVERTER

The ramp output amplifier consists of IC940 and output transistor Q946. They provide the low impedance and phase inversion necessary for the positive ramp output. The VC phase inverter, IC975 and output transistor Q975, is similar to the output amplifier and is used to provide the negative drive for the main generator VC circuit.

4.8 POWER SUPPLY (See Figure 9)

The power supply provides positive and negative 17 volt regulated power to all circuits. Zener CR111 is used as the reference in the positive supply; the negative supply, which is similar, is referred to the positive supply. Q101 is a series regulator; variations in output voltage are sensed by Q106, whose emitter voltage is determined by Zener CR111; Q105 provides temperature compensation. The output of Q106 is applied to the base of Q102 which drives Q101. A short circuit from + 17 volts to ground would shut off Q101 providing short circuit protection.

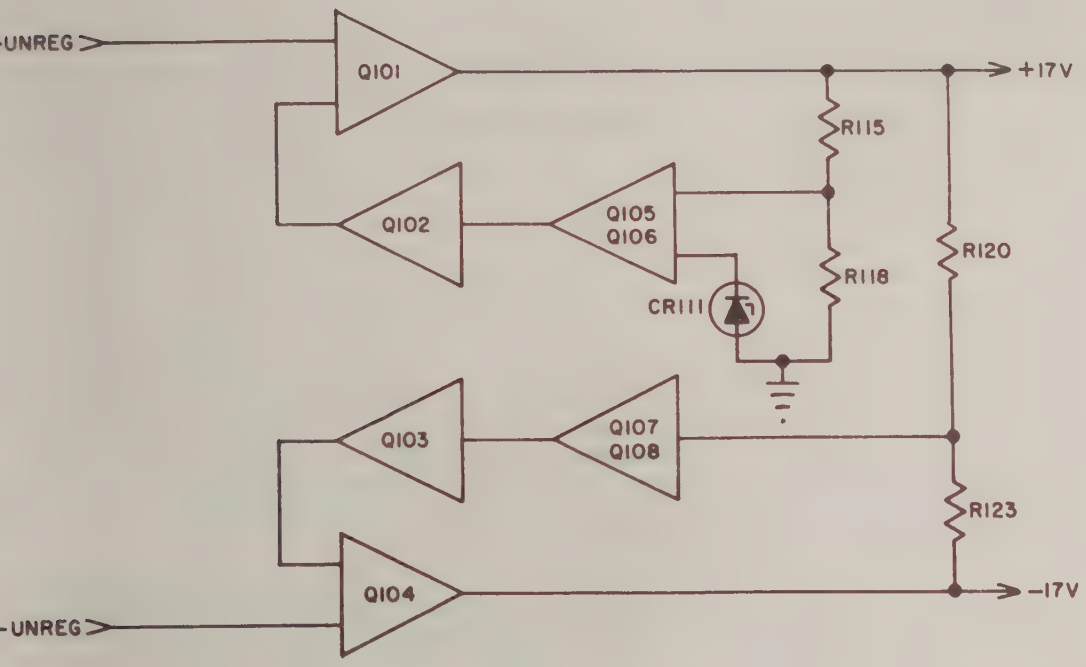


Figure 9. Power Supply

SECTION 5

MAINTENANCE

5.1 INTRODUCTION

If the generator is not functioning properly and requires service, the following procedure may facilitate locating the source of the trouble. Access to the interior of the generator is accomplished by removing the four screws centered at the rear of each cover; sliding off the side covers will unlock the top and bottom covers. The generator consists of a power supply printed circuit card, PC507, located in the rear of the chassis, a main generator printed circuit card, PC505, and a ramp generator printed circuit card, PC509.

When a malfunction is detected, first check the line voltage and line fuse and then make an inspection for broken wires, burnt or loose components, poor solder joints or similar conditions which could cause trouble. Before beginning trouble-shooting, it should be determined if the normal adjustments mentioned in the Calibration and Adjustment procedure, Section 6, will correct the trouble. Any troubleshooting of the generator will be greatly simplified if there is an understanding of the operation of the circuit: reference should be made to the Circuit Description, Section 4. The following procedure should be used in the sequence given.

5.2 TROUBLESHOOTING PROCEDURE

After allowing the instrument to warm up for 30 minutes, set the controls to the following positions:

FREQUENCY DIAL AND MULTIPLIER	20 X100
MODE	CONT
AMPLITUDE	Max. CW
WAVEFORM	Triangle
DC OFFSET	Off
SWEEP TIME	1ms-.1s, vernier Max. CCW
RAMP OFFSET	Max. CCW
RAMP AMPLITUDE	Max. CW
LIN SWP - LOG SWP	LIN SWP

Step No.	Mode	Symptom	Check	Faulty Circuitry and/or Assoc. Comp.	Trouble-shooting Section
1	Cont.	No Main or Ramp Output	Power Supply		
1a	Cont.	Power Supply Voltages Incorrect		Power Supply	5.3
2	Cont.	No Main Output, Ramp Output Normal	Stop Amp.		5.4
2a	Cont.	Stop Amp. Normal		Main Generator	5.6
3	Cont.	Main Output Normal, No Lin. or Exp. Ramp Output	Aux. Ramp Output		
3a	Cont.	Aux. Ramp Output Defective		Sawtooth Gen.	5.7
3b	Cont.	Aux. Ramp Output Normal	Ramp on emitter of Q941		
3c	Cont.	No Ramp on Emitter of Q941		Q940, Q941, Q942	
3d	Cont.	Emitter of Q941 Normal		IC940, Q946	
4	Cont.	Lin. Ramp Normal, Exp. Ramp Defective		Q943, Q944, Q945	
5	Cont.	Exp. Ramp Normal, Lin. Ramp Defective		S903	
6	Gate	Main Gen. Running with no External Input		Q842, Q841, Q840	
7	Gate	Man Trig Normal, External Gate Voltage Defective		Q850	
8	Gate	External Gate Normal, Man Trig Defective		Q904	
9	Gate	No Main Output when Man Trig Button Held In or Gate Voltage Applied	Pin 5 of IC850 should be 0 ± .1V		
10	Gate	Pin 5 of IC850 not 0 volts with Man Trig held In		IC850	
11	Pulse	No Pulse Signal		Signal Path from Collector of Q887 to Pin 3 of IC850	
12	Ext VC	No Main Output with an External 5 volts		IC975, Q975	
13	Trig Swp	Main Output will not Burst when Triggered or Free Runs		Q882	

5.3 POWER SUPPLY

An apparent failure of the plus and minus 17 volt supplies may be caused by excessive current being drawn by other parts of the circuit. An abnormal load on the plus 17 volt supply may cause the plus supply to drop to less than plus 2 volts. Due to the interaction of the plus and minus supplies, the minus 17 volts would probably increase to approximately 26 volts. An excessive load on the minus supply would cause it to drop to less than minus 2 volts and the plus supply would remain plus 17 volts.

If the power supply is defective, the following procedure is recommended. Due to the interactions between the plus and minus supplies, the malfunctioning supply will, in most cases, be the supply with the greatest error. The plus 17 volt supply is used as a reference supply for the minus 17 volt supply, and this fact should be kept in mind when doing any work on the supply.

Normal voltages for various points are given on the Schematic Diagram in the Appendix. The normal ripple on the plus and minus 17 volts supplies is less than (3 millivolts rms) 10 millivolts peak to peak. If the supplies are not working properly, trace the error signal developed through the circuit to find the faulty component.

For example, if the plus supply were lower than normal, the base of Q106 would become more negative than normal, thus increasing the current in Q106. This action would make the base of Q102 more positive, increasing the current in Q102, turning on the series transister Q101 and restoring the plus 17 to its normal level. The point at which this corrective action is blocked will localize the defective component. In the same manner, if the minus 17 volt supply is not negative enough, Q108 would have less current than normal, thus increasing the current in Q103 which in turn increases the current in the series transistor Q104 and restoring the minus supply to its correct value. If it is necessary to replace the reference zener, CR111, it will probably be necessary to adjust R118B for the correct plus voltage.

If it appears that the power supply is excessively loaded, remove the four leads that connect the PC505 and PC507 together. Measure the resistance from the signal ground to the plus and minus 17 volt test points. The resistance should not be less than 30 ohms in either supply. If it is low in either supply, trace the lowest resistance path to all other circuits by lifting jumpers or components.

5.4 STOP AMPLIFIER

Measure the voltage on the base and collector of Q840. If the junction is reversed biased, (i.e. base more positive than the collector), the problem is in the Main Generator and the trouble can be located by referring to Section 5.5.

If the junction is forward biased, (i.e. collector 0.7 volts more positive than the base), the problem is in the Stop Amplifier (Q840, Q841 and Q842). In the CONT mode, Q841 and Q842 should be off.

5.5 VC AMPLIFIER

When it appears that the problem is in the VC Amplifier, IC401, Q401, Q402, Q403 and associated circuitry may be defective. If either Q401 or Q402 are changed, the following procedure should be used in re-trimming R415A:

(1) Ground testpoint TI.

(2) Connect testpoint FI to the +17 volt testpoint, thru a 2K resistor.

(3) Set Frequency Dial to 2, Multiplier to X100.

(4) Measure the dc voltage at testpoint ME and SE. Adjust R415B to make the dc voltage equal to within ± 1 millivolt of each other.

5.6 MAIN GENERATOR

Symptom	Check	Probable Defective Component
No signal Main and Fixed 5V Square Wave Outputs	1. Mode switch should be in CONT position	1.
	2. Tuning pot center arm (-8±1V)	2. Tuning pot or Mode switch
	3. Test point ME dc voltage (+ 8±1V)	3. VC Amplifier Refer to Section 5.5
	4. Polarity at testpoint TI should be opposite that at TO	4. Integrator
	5. Voltage at TO should be above + 10V or below -10V	5. Integrator
	6. Check voltage at test point SE	6a. If TO ≥ + 10V, and SE = + 8, Integrator or network
		6b. If TO ≥ + 10V and SE = 0, Flip-flop or Q401
		6c. If TO ≤ -10V, and SE = + 8V, Flip-flop or Q401
		6d. If TO ≤ -10V and SE ≅ 0, Integrator or network
No signal on main output, fixed output normal	1. Check for signal (3V p-p) on center arm when R529 output amplitude pot is maximum CW	1. Function Switch

Symptom	Check	Probable Defective Component
No signal on main output, fixed output normal (contd.)	2. Check signal on R521 (20V p-p)	2. Output amplifier
	3. If signal on R521 is correct	3. Attenuator
Sine wave only missing	1. Test point AI should be 0vdc with very small signal. If AI dc level is not 0vdc, level on Q233 collector should be of opposite polarity	1. Sine Amplifier (Q231, etc.)
	2. If sine amp appears normal, check the sine shaper	2. Sine shaper
Main and auxiliary square wave missing	1. Signal on Junction of R365 and R368 should be the same as on collector of Q344	1. Q361, Q362
Main square wave only missing	1. Check all positions of waveform switch	1. Waveform switch
Defective signal as tuning dial is turned	1. As dial is turned from 2 to 30, dc voltage on tuning pot center arm should vary from -0.8 to -12 vdc, and voltage on test point ME should vary from + 0.8 to + 12 vdc.	1a. Tuning potentiometer 1b. VC Amplifier. Refer to Section 5.5
	2. If trouble is at low frequency at end of dial only, check square symmetry	2. Integrator

5.7 SAWTOOTH GENERATOR

If the junction of CR890 and CR891 is approximately zero or a positive voltage, check steps 1 thru 4 and 10-14. If the junction of CR890 and CR891 is approximately equal to -12 volts, check steps 5-14.

Step No.	Measure	Correct Reading	Faulty Semi-conductor and Assoc. Circuit
1	Collector of Q881	≈0 or positive	Q880, Q881
2	Pin 1 of IC880	≈-17V	Q884, Q885
3	Pin 5 of IC880	≈-17V	IC880
4	Collector of Q883	≈-8V	Q883
5	Collector of Q884	-12V to -15.5V	Q882, Q884, Q885
6	Pin 3 of IC880	≈-17V	Q880, Q881
7	Pin 5 of IC880	≈-15.6V	IC880
8	Collector of Q883	≈-16V	Q883
9	Gate of Q886	-15V	CR883
10	Source of Q886	≈-12V	Q886
11	Emitter of Q887	≈-15.7V	Q887, Q888
12	Base of Q887	Determine if Q887 is on or off.	
13	Collector of Q887	Not consistent with above	Q887
14	Emitter of Q889	≈1.4V more positive than collector of Q887	Q889

SECTION 6

CALIBRATION

6.1 INTRODUCTION

The following procedure is provided for the calibration and adjustment of the generator in the field, and adherence to this procedure should restore the generato to its performance specifications. If the generator cannot be calibrated by the procedure given, refer to Maintenance Section 5, or consult our Factory Service Department.

6.2 TEST EQUIPMENT REQUIRED

(a) Oscilloscope having direct coupled horizontal and vertical amplifier with 10 mv/cm sensitivity and bandwidth of at least 30 MHz, Tektronix type 545 or equal with 1A5 plug-in unit.

(b) Frequency counter capable of measuring 0.01 Hz to 10 MHz.

(c) AC Voltmeter, Ballantine Type 323 or equal (±2% to 5 MHz).

(d) Calibrated voltage source, or regulated DC supply and digital voltmeter 0-15 volts, accuracy ±1 millivolt.

(e) Distortion meter Hewlett Packard Type 333A.

6.3 POWER SUPPLY

Turn the generator on, set the frequency to 5 X100 and allow it to warm up for about 30 minutes. Measure the voltage between ground and +17 volts and then -17 volts. Tolerances are ±0.5 volt. If off, trim R118B to bring both within 0.5 volt.

6.4 INTEGRATOR

Connect the oscilloscope to TI, and set the scope to 1 mv/cm (cal), ac coupled. Adjust R310 for minimum signal. (If the noise on the signal is excessive, connect a 7 KHz low pass filter in series with the probe, and make sure that the ground connection is close to TI. The 7 KHz filter may be fabricated by connecting a 10K resistor in series with the probe, with 0.0022 mfd capacitor connected from the scope end to ground).

6.5 AUXILIARY SQUARE WAVE

Set the frequency to 30 X100, and connect the auxiliary square wave output to the oscilloscope with a 50 ohm termination at the scope. Set the positive peak of the square wave to + 1.25 volts by means of R353, and the negative peak to -1.25 volts by means of potentiometer R367.

6.6 DC LEVELS

Set the Mode switch to the Cont position. Set the frequency to 5 X100, sine waveform; set the output amplitude control to the Max. CCW end. Connect the dc voltmeter to the MAIN OUTPUT, adjust the output level to 0 volts by means of the main output DC LEVEL ADJ control, R528 on the rear panel. Return the amplitude vernier to the max. CW end. Using the dc voltmeter, check the voltages listed in the table below, and if necessary adjust the potentiometers indicated; all should be set to 0 volt.

Voltage	Test Point	Adj. No.	Tolerance
Integrator input	**TI**	R308	± 1 mv
Integrator output (switch to ⩘)	**Main output**	R349	± 10 mv
Sine amplifier input	**AI**	R246	± 10 mv
Sine amplifier output	**Main output**	R231	± 20 mv

6.7 MAIN SQUARE WAVE

Switch the waveform to square wave, and connect the main output to the oscilloscope, with a 50 ohm terminator at the scope. Set the frequency to 30 X 100K. Adjust amplitude to 10 volts peak-to-peak. Adjust C515 for minimum droop and overshoot.

6.8 FREQUENCY CALIBRATION

Set the frequency dial at 2. The dc voltage across the two outside terminals of potentiometer R604 (center arm and low end of the dial pot), should be 0.19 volt. If it is not 0.19 volt, rotate the dial until it is, and mechanically adjust the position of the dial on the shaft so that the dial indicates 2. Connect the frequency counter to the output. Set the dial to 10, and the multiplier to X1. The frequency should be approximately 10 Hz. Switch to 10 X10. The frequency should be ten times as great. Adjust C603 for a 10 to 1 change between the X1 and X10 positions.

Set the dial to 2.5, mult. to X100K. Adjust C601 for 250 KHz ±1%. Set the dial to 29, mult. to X100K. Adjust C331 for 2.9 MHz ± 1%. Repeat both until both are within tolerance.

6.9 SINE WAVE DISTORTION

Connect the generator to the distortion analyzer; set WAVEFORM to sine, dial to 2, mult. to X1K, amplitude control to max. CW end. Set the distortion analyzer to 2 KHz and adjust for a null. Adjust the generator SYM ADJ pot on the rear panel and then pots R229 and R221 in the sine shaper for minimum distortion.

6.10 MAIN OUTPUT RAMP AND TRIANGLE ADJUSTMENTS

Connect the oscilloscope to the generator, with a 50 ohm terminator at the scope. Set the generator to ramp, dial to 10, mult. to X100. Switch from X100 to X100K. Adjust C702 for most linear slope at X100K. Switch to triangle waveform, and switch from X100 to X100K. Adjust C701 for most linear waveform at X100K.

6.11 SINE FREQUENCY RESPONSE

Set the generator to 20 X100, with the output terminated with a 50 ohm terminator at the acvm. Switch WAVEFORM to sine. Switch from 20 X100 (2KHz) to 10 X100K 10 X100K (100KHz) and then to 30 X100 KHz (3 MHz). Tolerance from 2 KHz to 100 KHz should be 0.5% and from 100 KHz to 3 MHz 1.5%. Adjust C231 to bring the 100K band within tolerance. Remove the 50 ohm terminator.

6.12 AUXILIARY SAWTOOTH ZERO LEVEL

Set the SWEEP TIME switch to the 1ms-.1s position, vernier to the max. CCW end. Set the RAMP AMPLITUDE control to the max. CW end and the RAMP OFFSET control to the max. CCW end. Set the MODE switch to the CONT SWP position. Connect the scope to the AUXILIARY SAWTOOTH (rear panel) output and adjust R884 so that the ZERO volt level of the RAMP is at 0 volts, ±10 millivolts.

6.13 RAMP CONTROL INTERACTION ADJUST

Connect the scope to the RAMP output. Set the LIN SWP-LOG SWP switch to the LOG SWP position. Adjust R940 so that the peak of the exponential ramp does not change when the RAMP OFFSET control is adjusted to max. CW end. Return the RAMP OFFSET control to the max. CCW end.

6.14 EXPONENTIAL RAMP SHAPE ADJUST

From the zero start point dc level adjust R951, so that the exponential ramp is 0.3 volts, when the ramp is at the 50% sweep time.

6.15 MINIMUM FREQUENCY - LOG SWP

Connect the scope to the MAIN output. Set the WAVEFORM switch to the SQUARE WAVE position. Connect a frequency counter to the MAIN output. Set the SWEEP TIME control to the 1us-1ms position. Turn the SWEEP WIDTH control to the max. CCW end. With the SYM ADJ optimized for a symmetrical square wave, the frequency should be between 20 Hz and 30 Hz. If off, adjust R966.

6.16 MINIMUM FREQUENCY - LIN SWP

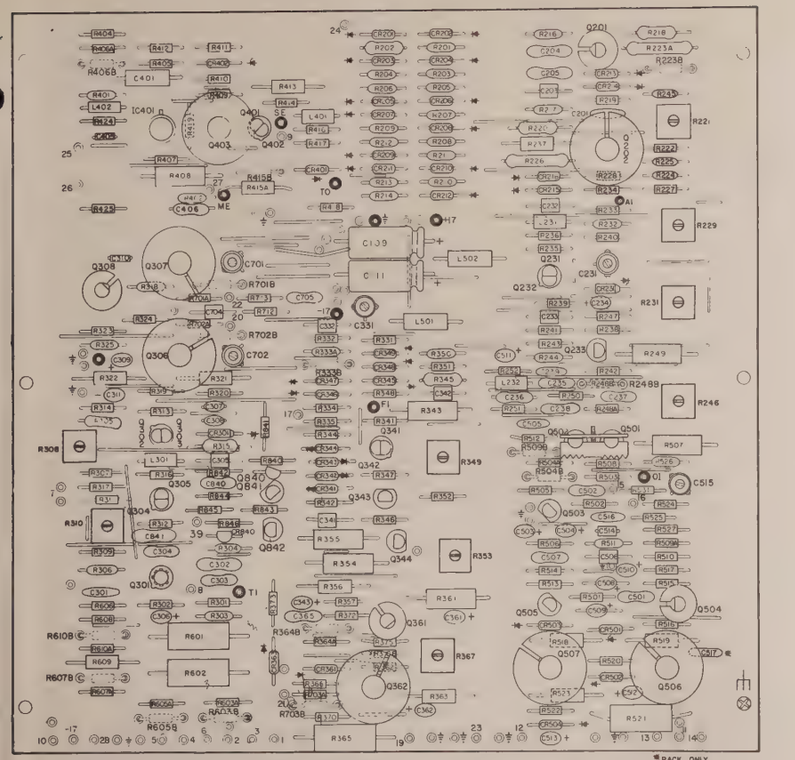
Set the LIN SWP-LOG SWP switch to the LIN SWP position. With the SYM ADJ optimized for a symmetrical square wave, the frequency should be between 20 Hz and 30 Hz. If off, adjust R963.

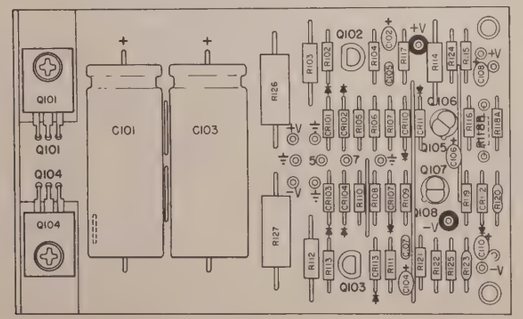
6.17 MAXIMUM FREQUENCY - LIN SWP

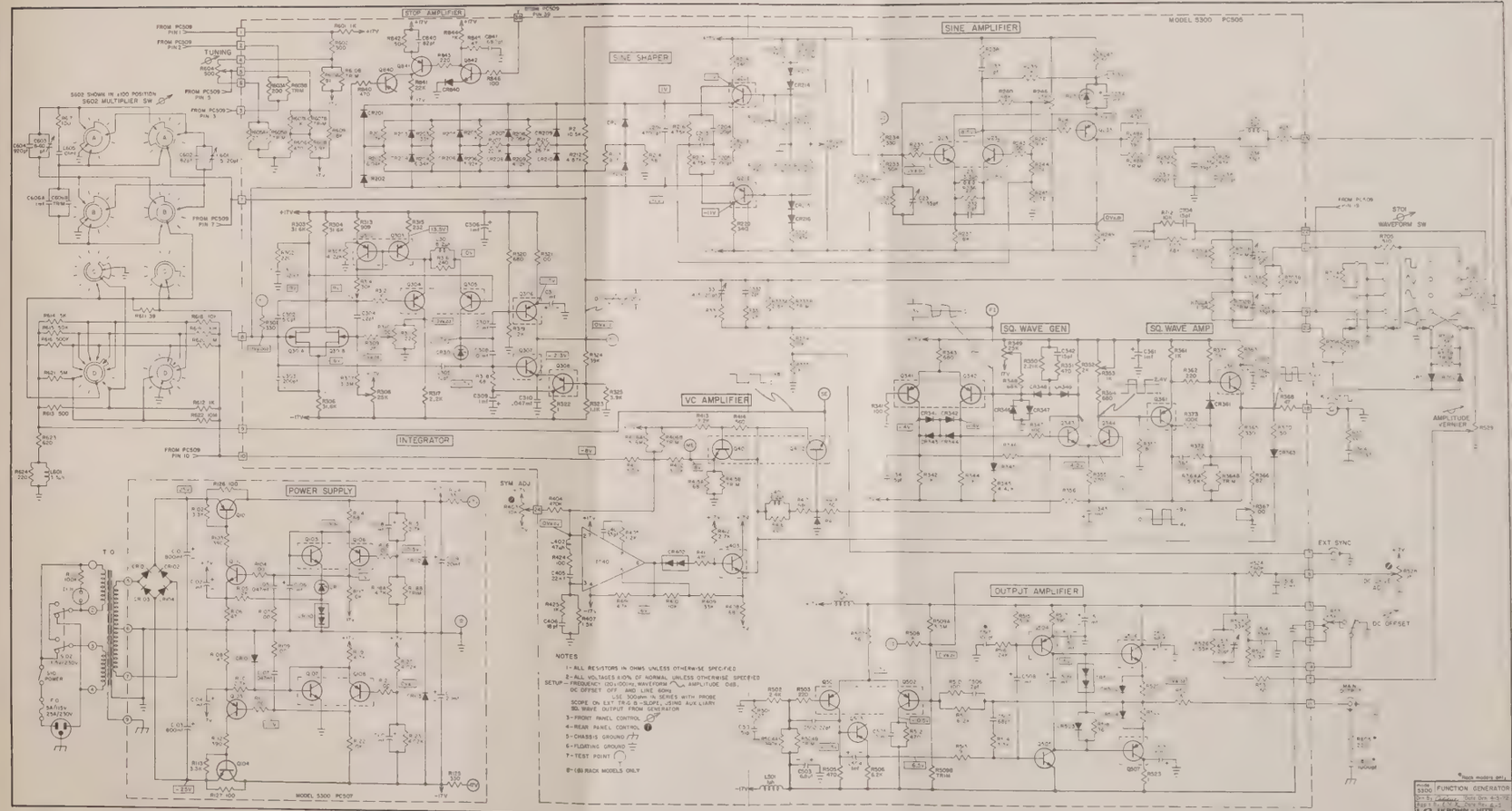
Set the MODE switch to the TRIG SWP HOLD position. Turn the SWEEP WIDTH control to the max. CW end. The frequency should be between 30 KHz and 32 KHz. If off, adjust R974.

6.18 MAXIMUM FREQUENCY - LOG SWP

Set the LIN SWP - LOG SWP Switch to the LOG SWP position. The frequency should be between 30 KHz and 32 KHz. If off, adjust R950.


MODEL 5200 PC505
RACK ONLY


PC507


MODEL 5300 PC506
STOP AMPLIFIER
SINE AMPLIFIER
SINE SHAPER
INTEGRATOR
VC AMPLIFIER
SQ. WAVE GEN
SQ. WAVE AMP
POWER SUPPLY
OUTPUT AMPLIFIER
TUNING
5602 MULTIPLIER SW
5701 WAVEFORM SW
AMPLITUDE VERNIER
DC OFFSET
EXT SYNC
SYM ADJ
NOTES
1- ALL RESISTORS IN OHMS UNLESS OTHERWISE SPECIFIED
2- ALL VOLTAGES ±10% OF NORMAL UNLESS OTHERWISE SPECIFIED
SETUP - FREQUENCY (20)(100)Hz WAVEFORM AMPLITUDE 0dB
DC OFFSET OFF AND LINE 60Hz
USE 500ohm IN SERIES WITH PROBE
SQ. WAVE OUTPUT FROM GENERATOR
3- FRONT PANEL CONTROL
4- REAR PANEL CONTROL
5- CHASSIS GROUND
6- FLOATING GROUND
7- TEST POINT
@-(8) RACK MODELS ONLY
MODEL 5300 PC507
FUNCTION GENERATOR
KIN TEL
A KOHIN - HITEL CORPORATION

RESISTORS

Symbol	Description			Mfr	Part No.
R101	100K	10%	1/4W	AB	CB1041
R102	3.3K	10%	1/4W	AB	CB3321
R103	390	10%	1/2W	AB	EB3911
R104	100	20%	1/4W	AB	CB1012
R105	1.2K	10%	1/4W	AB	CB1221
R106	47	10%	1/4W	AB	CB4701
R107	100	10%	1/4W	AB	CB1011
R108	47	10%	1/4W	AB	CB4701
R109	100	10%	1/4W	AB	CB1011
R110	2.7K	10%	1/4W	AB	CB2721
R111	100	10%	1/4W	AB	CB1011
R112	390	10%	1/2W	AB	EB3911
R113	3.3K	10%	1/4W	AB	CB3321
R114	680	10%	1/2W	AB	EB6811
R115	2.7K	10%	1/4W	AB	CB2721
R116	100	20%	1/4W	AB	CB1012
R117	10K	10%	1/4W	AB	CB1031
R118A	4.7K	10%	1/4W	AB	CB4721
R118B	TRIM			AB	TYPE CB
R119	4.7K	10%	1/4W	AB	CB4721
R120	4.02K	1%	1/8W	KH	M3-T1-4.02K
R121	100	20%	1/4W	AB	CB1012
R122	10K	10%	1/4W	AB	CB1031
R123	4.02K	1%	1/8W	KH	M3-T1-4.02K
R124	330	10%	1/4W	AB	CB3311
R125	330	10%	1/4W	AB	CB3311
R126	100	10%	5W	SE	1500S
R127	100	10%	5W	SE	1500S
R201	1.07K	1%	1/8W	KH	M3-T1-1.07K
R202	6.04K	1%	1/4W	KH	M4-T1-6.04K
R203	1.33K	1%	1/8W	KH	M3-T1-1.33K
R204	6.34K	1%	1/8W	KH	M3-T1-6.34K
R205	1.1K	1%	1/8W	KH	M3-T1-1.1K
R206	3.92K	1%	1/8W	KH	M3-T1-3.92K
R207	22.1K	1%	1/8W	KH	M3-T1-22.1K
R208	2.05K	1%	1/8W	KH	M3-T1-2.05K
R209	4.12K	1%	1/8W	KH	M3-T1-4.12K
R210	26.7K	1%	1/8W	KH	M3-T1-26.7K
R211	10.5K	1%	1/8W	KH	M3-T1-10.5K
R212	4.87K	1%	1/8W	KH	M3-T1-4.87K
R213	825	1%	1/8W	KH	M3-T1-825
R214	158	1%	1/8W	KH	M3-T1-158
R216	4.75K	1%	1/8W	KH	M3-T1-4.75K
R217	4.75K	1%	1/8W	KH	M3-T1-4.75K
R218	340	1%	1/4W	KH	M4-T1-340
R219	120	10%	1/4W	AB	CB1211
R220	340	1%	1/4W	KH	M4-T1-340
R221	25K POT			BKM	72PM
R222	1.5K	10%	1/4W	AB	CB1521
R223A	1.5K	1%	1/2W	KH	M5-T1-1.5K
R223B	TRIM			AB	TYPE CB
R224	182	1%	1/8W	KH	M3-T1-182
R225	182	1%	1/8W	KH	M3-T1-182
R226	1.43K	1%	1/2W	KH	M5-T1-1.43K
R227	150K	10%	1/4W	AB	CB1541
R228	150K	10%	1/4W	AB	CB1541
R229	25K POT			BKM	72PM
R231	25K POT			BKM	72PM
R232	681	1%	1/8W	KH	M3-T1-681
R233	150K	10%	1/4W	AB	CB1541
R234	330	10%	1/4W	AB	CB3311
R235	100	10%	1/4W	AB	CB1011
R236	150	10%	1/4W	AB	CB1511
R237	1.8K	10%	1/2W	AB	EB1821
R238	1K	10%	1/4W	AB	CB1021
R239	1K	5%	1/4W	AB	CB1025
R240	68K	10%	1/4W	AB	CB6831
R241	100	10%	1/4W	AB	CB1011
R242	91K	5%	1/4W	AB	CB9135
R243	100	10%	1/4W	AB	CB1011
R244	274	1%	1/8W	KH	M3-T1-274
R245	232	1%	1/4W	KH	M4-T1-232
R246	25K POT			BKM	72PM
R247	150	10%	1/4W	AB	CB1511
R248A	390	10%	1/4W	AB	CB3911
R248B	TRIM			AB	TYPE CB
R249	1K	10%	1W	AB	GB1021
R250	43K	5%	1/4W	AB	CB4335
R251	10	10%	1/4W	AB	CB1001
R252	150K	10%	1/4W	AB	CB1541
R301	330	10%	1/4W	AB	CB3311
R302	220	10%	1/4W	AB	CB2211
R303	31.6K	1%	1/8W	KH	M3-T1-31.6K
R304	31.6K	1%	1/8W	KH	M3-T1-31.6K
R305	4.22K	1%	1/4W	KH	M4-T1-4.22K
R306	31.6K	1%	1/8W	KH	M3-T1-31.6K
R307	3.3M	10%	1/4W	AB	CB3351
R308	25K POT			BKM	72PM
R309	10K	10%	1/4W	AB	CB1031
R310	100 POT			BKM	72PM
R311	22	10%	1/4W	AB	CB2201
R312	100	20%	1/4W	AB	CB1012
R313	909	1%	1/8W	KH	M3-T1-909
R314	30K	5%	1/4W	AB	CB3035
R315	232	1%	1/4W	KH	M4-T1-232
R316	240	5%	1/4W	AB	CB2415
R317	2.2K	10%	1/4W	AB	CB2221
R318	681	1%	1/8W	KH	M3-T1-681
R319	1.2K	10%	1/4W	AB	CB1221

Symbol	Description			Mfr	Part No.
R320	680	10%	1/4W	AB	CB6811
R321	100	5%	1/2W	AB	EB1015
R322	1	10%	1/2W	AB	EB1001
R323	1.1K	5%	1/4W	AB	CB1125
R324	39K	5%	1/4W	AB	CB3935
R325	3.9K	5%	1/4W	AB	CB3925
R331	1K	5%	1/4W	AB	CB1025
R332	22K	5%	1/4W	AB	CB2235
R333A	2.8K	1%	1/8W	KH	M3-T1-2.8K
R333B	TRIM			AB	TYPE CB
R334	10K	10%	1/4W	AB	CB1031
R335	1K	10%	1/4W	AB	CB1021
R341	100	20%	1/4W	AB	CB1012
R342	1.1K	5%	1/4W	AB	CB1125
R343	680	10%	1W	AB	GB6811
R344	1.1K	5%	1/4W	AB	CB1125
R345	4.42K	1%	1/4W	KH	M4-T1-4.42K
R346	100	20%	1/4W	AB	CB1012
R347	100	20%	1/4W	AB	CB1012
R348	68K	10%	1/4W	AB	CB6831
R349	25K POT			BKM	72PM
R350	2.21K	1%	1/8W	KH	M3-T1-2.21K
R351	470	10%	1/4W	AB	CB4711
R352	2K	5%	1/4W	AB	CB2025
R353	1K POT			BKM	72PM
R354	680	10%	1W	AB	GB6811
R355	270	5%	1W	AB	GB2715
R356	1	10%	1/2W	AB	EB1001
R357	180	5%	1/4W	AB	CB1815
R361	1K	10%	1W	AB	GB1021
R362	220	10%	1/4W	AB	CB2211
R363	120	10%	1/2W	AB	EB1211
R364A	5.6K	10%	1/4W	AB	CB5621
R364B	TRIM			AB	TYPE CB
R365	330	10%	2W	AB	HB3311
R366	82	10%	1/4W	AB	CB8201
R367	100 POT			BKM	72PM
R368	47	10%	1/4W	AB	CB4701
R370	150	10%	1/4W	AB	CB1511
R371	220	10%	1/4W	AB	CB2211
R372	220	10%	1/4W	AB	CB2211
R373	100K	10%	1/4W	AB	CB1041
R375	10K	10%	1/4W	AB	CB1031
R4C1	3.01K	0.1%	1/8W	KH	M3-T1-3.01K
R402	3.01K	0.1%	1/8W	KH	M3-T1-3.01K
R403	10K POT			CTS	307089
R404	470K	10%	1/4W	AB	CB4741
R405	1.2L	10%	1/4W	AB	CB1221
R406A	5.6M	10%	1/4W	AB	CB5651
R406B	TRIM			AB	TYPE CB
R407	1.5K	10%	1/4W	AB	CB1521
R408	680	10%	1W	AB	GB6811
R409	33K	10%	1/4W	AB	CB3331
R410	10K	10%	1/4W	AB	CB1031
R411	470	10%	1/4W	AB	CB4711
R412	2.7K	10%	1/4W	AB	CB2721
R413	2.2K	10%	1/2W	AB	EB2221
R414	560	10%	1/4W	AB	CB5611
R415A	680	10%	1/2W	AB	EB6811
R415B	TRIM			AB	TYPE CB
R416	220	10%	1/4W	AB	CB2211
R417	680	10%	1/4W	AB	CB6811
R418	150	10%	1/4W	AB	CB1511
R419	4.7K	10%	1/4W	AB	CB4721
R424	120 (5200)	10%	1/4W	AB	CB1211
R424	100 (5300)	10%	1/4W	AB	CB1011
R425	1K	10%	1/4W	AB	CB1021
R501	27	10%	1/4W	AB	CB2701
R502	2.4K	5%	1/4W	AB	CB2425
R503	220	10%	1/4W	AB	CB2211
R504A	390K	10%	1/4W	AB	CB3941
R504B	TRIM			AB	TYPE CB
R505	470	10%	1/4W	AB	CB4711
R506	6.2K	5%	1/4W	AB	CB6225
R507	560	10%	1W	AB	GB5611
R508	1K	10%	1/4W	AB	CB1021
R509A	3.3M	10%	1/4W	AB	CB3351
R509B	TRIM			AB	TYPE CB
R510	100	10%	1/4W	AB	CB1011
R511	16.2K	1%	1/8W	KH	M3-T1-16.2K
R512	470	10%	1/4W	AB	CB4711
R513	91	5%	1/4W	AB	CB9105
R514	3.3K	5%	1/4W	AB	CB3325
R515	5.1K	5%	1/4W	AB	CB5125
R516	24K	5%	1/4W	AB	CB2435
R517	390	10%	1/4W	AB	CB3911
R518	36	5%	1/2W	AB	EB3605
R519	1	10%	1/2W	AB	EB1061
R520	10	10%	1/4W	AB	CB1001
R521	51	5%	2W	AB	HB5105
R522	10	10%	1/4W	AB	CB1001
R523	1	10%	1/2W	AB	EB1061
R524	560K	10%	1/4W	AB	CB5641
R525	33K	10%	1/4W	AB	CB3331

RESISTORS (CONT'D)

Symbol	Description			Mfr	Part No.
R526	2.55K	1%	1/8W	KH	M3-T1-2.55K
R527	3.3K	10%	1/4W	AB	CB3321
R528	10K POT			CTS	307089
R529	500 POT			KH	B2928
R530	5K POT			KH	4293B
R531	150	10%	1/4W	AB	CB1571
R601	1	10%	2W	AE	HB1021
R602	390	5%	1W	AB	GB3915
R603A	200	5%	1/4W	AB	CB2015
R603B	TRIM			AB	TYPE CB
R604	500 POT			KH	B2928
R605A	27	10%	1/4W	AB	CB2701
R605B	TRIM			AB	TYPE CB
R606	470	10%	1/4W	AB	CB4711
R607A	10K	10%	1/4W	AB	CB1031
R607B	TRIM			AB	TYPE CB
R608	1.9K	10%	1/4W	AB	CB1925
R609	1.8K	5%	1/2W	AB	EB1825
R610A	93	1%	1/4W	KH	M4-T1-93
R610B	TRIM			AB	CB9705
R611	39	10%	1/4W	AB	CB3901
R612	1K	0.1%	1/4W	KH	M4-T1-1K
R613	500	0.1%	1/2W	KH	M5-T1-500
R614	5K	0.1%	1/8W	KH	M3-T1-5K
R615	50K	0.1%	1/8W	KH	M3-T1-50K
R616	500K	0.1%	1/4W	KH	M4-T1-500K
R617	100	10%	1/4W	AB	CB1011
R618	10K	0.1%	1/8W	KH	M3-T1-10K
R619	100K	0.1%	1/8W	KH	M3-T1-100K
R620	1M	1%	1/2W	KH	M5-T1-1M
R621	5M	1%	1/2W	KH	M11-5M
R622	10M	2%	1W	KH	M12-10M
R623	620	10%	1/2W	AB	EB6221
R624	200	10%	1/4W	AB	CB2211

Symbol	Description			Mfr	Part No
R701A	2.2K	5%	1/4W	AB	CB2225
R701B	TRIM			AB	TYPE CB
R702A	1.5K	5%	1/4W	AB	CB1525
R702B	TRIM			AB	TYPE CB
R703	500	10%	4W	AB	EB5011
R704	TRIM			AB	TYPE CB
R705	470	10%	1/4W	AB	CB4721
R706	68	5%	1/4W	AB	CB6805
R707	1K	5%	1/4W	AB	CB1025
R708	100	10%	1/4W	AB	CB1011
R709	470	10%	1/4W	AB	CB4711
R710A	1K	5%	1/4W	AB	CB1025
R710B	TRIM			AB	TYPE CB
R801	442	1%	1/8W	KH	M3-T1-442
R802	61.8	1%	1/8W	KH	M3-T1-61.8
R803	442	1%	1/8W	KH	M3-T1-442
R804	5K	1%	1/8W	KH	M3-T1-5K
R805	442	1%	1/8W	KH	M3-T1-442
R840	470	10%	1/4W	AB	CB4711
R841	22K	10%	1/4W	AB	CB2231
R842	15	10%	1/4W	AB	CB1510
R843	2.7K	1%	1/4W	AB	CB2721
R844	1K	1%	1/4W	AB	CB1021
R845	47	10%	1/4W	AB	CB4701
R846	100	1%	1/4W	AB	CB1001

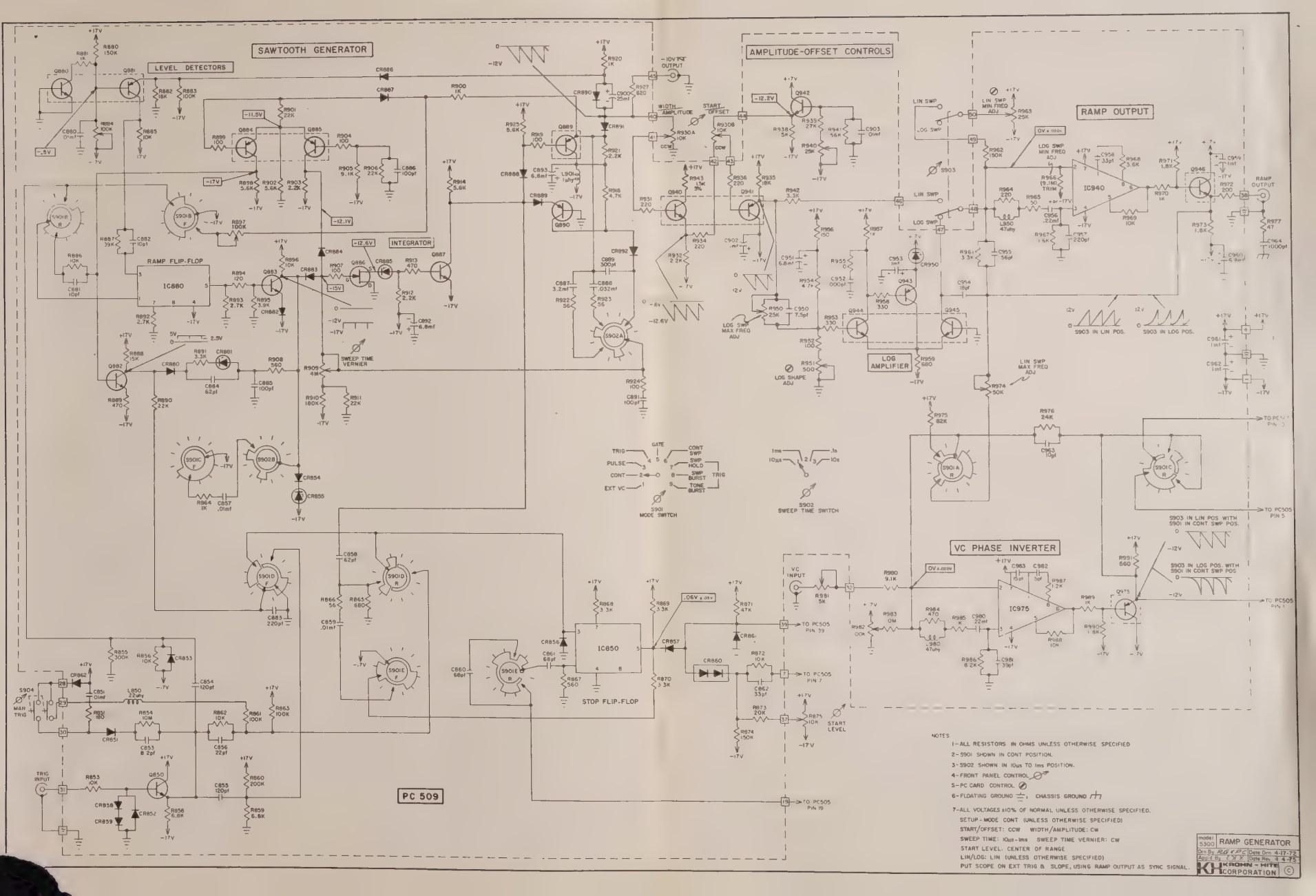
CAPACITORS

Symbol	Description			Mfr	Part No.
C101	820pf	1%T1	4Hv	MAL	TC820M1H471E1F
C102	1mf	20%	35V	MAL	TDC105M035AL
C103	820mf	1%T1C	40V	MAL	TC820M1H471E1PTF
C104	1mf	20%	35V	MAL	TDC105M035AL
C105	.047mf	20%	100V	ERT	8121-100-651-473M
C106	1mf	20%	35V	MAL	TDC105M035AL
C107	047mf	20%	100V	ERT	8121-100-651-473M
C108	1mf	20%	35V	MAL	TDC105M035AL
C109	20mf	1%T1	50V	SP	30D206G050CC4
C110	1mf	20%	35V	MAL	TDC105M035AL
C111	20mf	1%T1C	50V	SP	30D206G050CC4
C201	4730pf	20%	500V	SP	C023B5H1E472M
C203	2pf	10%	500V	ASP	9210-10110
C204	100pf	10%	500V	ELM	DM15C101J
C205	100mf	10%	500V	ELM	DM15C101J
C231	7-35pf	TRIMMER		STT	TRIM0-02-N1500
C232	10pf	10%	500V	ASP	9213-10110
C233	10pf	10%	500V	ASP	9213-10110
C234	1mf	20%	35V	MAL	TDC105M035AL
C235	39pf	10%	500V	ELM	DM15C390K
C236	33pf	10%	500V	ELM	DM15C330K
C237	47pf	10%	500V	ELM	DM15C470K
C238	200pf	10%	500V	ELM	DM15C201K
C239	1000pf	20%	500V	SP	C023B5H1E102M
C301	.02mf	20%	500V	SP	C023A5G1C203M
C302	510pf	10%	500V	ELM	DM19C511F
C303	200pf	10%	500V	ELM	DM15C201K
C304	22pf	10%	500V	ELM	DM15C220K
C305	10pf	10%	500V	ASP	9213-10110
C306	1mf	20%	35V	MAL	TDC105M035AL
C307	.01mf	20%	500V	SP	C023B5G1C103M
C308	.01mf	20%	500V	SP	C023B5G1C103M
C309	1mf	20%	35V	MAL	TDC105M035AL
C310	.047mf	20%	100V	ERT	8121-100-651-473M
C311	1mf	20%	35V	MAL	TDC105M035AL
C331	4.5-20pf	TRIMMER		STT	TRIM0-02-N750
C332	12pf	10%	500V	ASP	9213-10110
C341	15pf	10%	500V	ASP	9300-15110
C342	15pf	10%	500V	ASP	9300-15110
C343	1mf	20%	35V	MAL	TDC105M035AL

Symbol	Description			Mfr	Part No.
C401	1mf	20%	35V	MAL	TDC105M035AL
C402	15pf	10%	500V	ASP	9300-15110
C403	2pf	10%	500V	ASP	9210-10110
C404	18pf	10%	500V	ELM	DM15C180J
C364	1000pf	20%	500V	ELM	DM15C102M
C365	100pf	10%	500V	ELM	DM15C101J
C501	6.8mf	20%	35V	SP	196D685X0035FB
C502	1mf	20%	35V	MAL	TDC105M035AL
C503	01mf	20%	500V	ASP	9213-10110
C504	68pf	10%	500V	ELM	DM15C680J
C505	1mf	20%	35V	MAL	TDC105M035AL
C506	1mf	20%	35V	MAL	TDC105M035AL
C510	1mf	20%	35V	MAL	TDC105M035AL
C511	1mf	20%	35V	MAL	TDC105M035AL
C512	6.8mf	20%	35V	SP	196D685X0035FB
C513	6.8mf	20%	35V	SP	196D685X0035FB
C514	33mf	20%	100V	ERT	8121-100-651-334M
C515	4.5-20pf	TRIMMER		STT	TRIM0-02-N1500
C516	.01mf	20%	500V	SP	C023B5G1C103M
C517	1000pf	20%	500V	SP	C023B5G1E102M
C601	1.5-20pf	TRIMMER		ELM	TK20Z
C602	82pf	10%	500V	ELM	DM15C820J
C603	8-60pf	TRIMMER		ELM	TK40Z
C604	920pf	1%	500V	ELM	DM19C921F
C605	.01mf	20%	500V	SP	C023B5G1C103M
C606A	1mf	-2%-4%	200V	TRW	Y663F-R
C606B	TRIM				
C701	4.5-20pf	TRIMMER		STT	TRIM0-02-N750
C702	7-35pf	TRIMMER		STT	TRIM0-02-N1500
C703	18pf	10%	500V	ELM	DM15C180J
C704	15pf	10%	500V	ASP	9301-15110
C705	51pf	10%	500V	ELM	DM15C510J
C801	1000pf	20%	500V	SP	C023B5G1E102M
C840	82pf	10%	500V	ELM	DM15C820J
C841	680pf	10%	500V	ELM	DM19C681K

TRANSISTORS, DIODES & MISC.

Symbol	Description	Mfr	Part No
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]



NOTES

1-ALL RESISTORS IN OHMS UNLESS OTHERWISE SPECIFIED

2-S901 SHOWN IN CONT POSITION.

3-S902 SHOWN IN 10µs TO 1ms POSITION.

4-FRONT PANEL CONTROL

5-PC CARD CONTROL

6-FLOATING GROUND, CHASSIS GROUND

7-ALL VOLTAGES ±10% OF NORMAL UNLESS OTHERWISE SPECIFIED.
SETUP-MODE CONT (UNLESS OTHERWISE SPECIFIED)
START/OFFSET: CCW WIDTH/AMPLITUDE: CW
SWEEP TIME: 10µs-1ms SWEEP TIME VERNIER: CW
START LEVEL: CENTER OF RANGE
LIN/LOG: LIN (UNLESS OTHERWISE SPECIFIED)
PUT SCOPE ON EXT TRIG & SLOPE, USING RAMP OUTPUT AS SYNC SIGNAL.

model 5300	RAMP GENERATOR
Drn By RG & PC	Date Drn. 4-17-72
Appd By F.S.W.	Date Rev. 4-4-75

KROHN-HITE CORPORATION ©

RESISTORS

Symbol	Description			Mfr.	Part No.
R851	180	5%	1/4W	AB	CB1815
R853	10k	10%	1W	AB	GB1031
R854	10M	10%	1/4W	AB	CB1061
R855	300K	5%	1/4W	AB	CB3045
R856	10K	10%	1/4W	AB	CB1031
R858	6.8K	10%	1/4W	AB	CB6821
R859	6.8K	10%	1/4W	AB	CB6821
R860	200K	5%	1/4W	AB	CB2045
R861	100K	10%	1/4W	AB	CB1041
R862	10K	10%	1/4W	AB	CB1031
R863	100K	10%	1/4W	AB	CB1041
R864	1k	10%	1/4W	AB	CB1021
R865	680	10%	1/4W	AB	CB6811
R866	56	10%	1/4W	AB	CB5601
R867	560	10%	1/4W	AB	CB5611
R868	3.3K	10%	1/4W	AB	CB3321
R869	3.3K	10%	1/4W	AB	CB3321
R870	3.3k	10%	1/4W	AB	CB3321
R871	47K	10%	1/4W	AB	CB4731
R872	10K	10%	1/4W	AB	CB1031
R873	20K	5%	1/4W	AB	CB2035
R874	150K	10%	1/4W	AB	CB1541
R875	10K POT	20%	1/2W	AB	GAIN056P103MA
R880	150K	10%	1/4W	AB	CB1541
R881	1K	10%	1/4W	AB	CB1021
R882	18K	10%	1/4W	AB	CB1831
R883	100K	10%	1/4W	AB	CB1041
R884	100K POT			BKM	72PM
R885	10K	10%	1/4W	AB	CB1031
R886	10K	10%	1/4W	AB	CB1031
R887	39K	10%	1/4W	AB	CB3931
R888	15K	10%	1/4W	AB	CB1531
R889	470	10%	1/4W	AB	CB4711
R890	22K	10%	1/4W	AB	CB2231
R891	3.3K	10%	1/4W	AB	CB3321
R892	2.7K	10%	1/4W	AB	CB2721
R893	2.7K	10%	1/4W	AB	CB2721
R894	120	10%	1/4W	AB	CB1211
R895	3.9K	10%	1/4W	AB	CB3921
R896	10K	10%	1/4W	AB	CB1031
R897	100K POT			BKM	72PM
R898	5.6K	10%	1/4W	AB	CB5621
R899	100	10%	1/4W	AB	CB1011
R900	1K	5%	1/4W	AB	CB1025
R901	22K	10%	1/4W	AB	CB2231
R902	5.6K	10%	1/4W	AB	CB5621
R903	2.2K	10%	1/4W	AB	CB2221
R904	100	10%	1/4W	AB	CB1011
R905	9.1K	5%	1/4W	AB	CB9125
R906	22K	10%	1/4W	AB	CB2231
R907	100	10%	1/4W	AB	CB1011
R908	560	10%	1/4W	AB	CB5611
R910	180K	5%	1/4W	AB	CB1845
R911	22K	5%	1/4W	AB	CB2235
R912	2.2K	10%	1/4W	AB	CB2221
R913	470	10%	1/4W	AB	CB4711
R914	5.6K	10%	1/4W	AB	CB5621
R919	4.7K	10%	1/4W	AB	CB4721
R919	100	10%	1/4W	AB	CB1011

Symbol	Description			Mfr.	Part No.
R920	1K	10%	1W	AB	GB1021
R921	2.2K	10%	1/4W	AB	CB2221
R922	56	10%	1/4W	AB	CB5601
R923	56	10%	1/4W	AB	CB5601
R924	100	10%	1/4W	AB	CB1011
R925	5.6K	10%	1/4W	AB	CB5621
R927	620	10%	1/4W	AB	CB6211
R930A	10K POT	20%	1W	AB	A2988
R930B	10K POT	20%	1W	AB	A2988
R931	220	10%	1/4W	AB	CB2211
R932	2.2K	10%	1/4W	AB	CB2221
R934	220	10%	1/4W	AB	CB2211
R935	18K	10%	1/4W	AB	CB1831
R936	220	10%	1/4W	AB	CB2211
R938	1.5K	10%	1/4W	AB	CB1521
R939	27K	10%	1/4W	AB	CB2731
R940	25K POT			BKM	72PM
R941	56K	10%	1/4W	AB	CB5631
R942	3.3K	5%	1/4W	AB	CB3325
R943	1.5K	5%	1/4W	AB	CB1525
R950	25K POT			BKM	72PM
R951	500 POT			BKM	72PM
R952	100	10%	1/4W	AB	CB1011
R953	330	10%	1/4W	AB	CB3311
R954	14.7K	1%	1/8W	KH	M3-T1-14.7K
R955	10	10%	1/4W	AB	CB1001
R956	150	10%	1/4W	AB	CB1511
R957	1K	10%	1/4W	AB	CB1021
R958	330	10%	1/4W	AB	CB3311
R959	680	10%	1W	AB	GB6811
R961	3.3K	5%	1/4W	AB	CB3325
R962	150K	10%	1/4W	AB	CB1541
R963	25K POT			BKM	72PM
R964	100	10%	1/4W	AB	CB1011
R965	150	10%	1/4W	AB	CB1511
R966	9.1M	5%	1/4W	AB	CB9155
R967	1.6K	5%	1/4W	AB	CB1625
R968	3.6K	5%	1/4W	AB	CB3625
R969	10K	10%	1/4W	AB	CB1031
R970	1K	10%	1/4W	AB	CB1021
R971	1.8K	10%	1/4W	AB	CB1821
R972	200	5%	1/4W	AB	CB2015
R973	1.8K	10%	1/2W	AB	EB1821
R974	50K POT			BKM	72XM
R975	82K	10%	1/4W	AB	CB8231
R976	24K	5%	1/4W	AB	CB2435
R977	47	10%	1/4W	AB	CB4701
R980	9.1K	5%	1/4W	AB	CB9125
R982	100K POT			BKM	72PM
R983	10M	10%	1/4W	AB	CB1061
R984	470	10%	1/4W	AB	CB4711
R985	1K	10%	1/4W	AB	CB1021
R986	8.2K	10%	1/4W	AB	CB8221
R987	1.2K	10%	1/4W	AB	CB1221
R988	10K	10%	1/4W	AB	CB1031
R989	1K	10%	1/4W	AB	CB1021
R990	1.8K	10%	1/4W	AB	CB1821
R991	560	10%	2W	AB	HB5611

CAPACITORS

Symbol	Description			Mfr.	Part No
C851	.02mf	20%	500V	SP	C023A501G203M
C854	8.2pf	10%	500V	ASP	9212B2910
C854	120pf	5%	500V	ELM	DM15C121J
C856	120pf	5%	500V	ELM	DM15C121J
C856	22pf	10%	500V	ELM	DM15C220K
C857	.01mf	20%	500V	SP	C023B501G103M
C858	62pf	10%	500V	ELM	DM15C620K
C859	.01mf	20%	500V	SP	C023B501G103M
C860	68pf	10%	500V	ELM	DM15C680K
C861	68pf	10%	500V	ELM	DM15C680K
C862	33pf	5%	500V	ELM	DM15C330J
C880	.01mf	20%	500V	SP	C023B501G103M
C881	10pf	10%	500V	ASP	9213-10110
C882	10pf	10%	500V	ASP	9213-10110
C883	220pf	10%	500V	ELM	DM15C221K
C884	62pf	10%	500V	ELM	DM15C620K
C885	100pf	10%	500V	ELM	DM15C101K
C886	100pf	10%	500V	ELM	DM15C101K
C887	5.2mf	+5-3 %	50V	TRW	X663F-12
C888	.042mf	+1-3 %	300V	TRW	X663F-3
C889	300pf	5%	500V	ELM	DM19C301J
C891	100pf	10%	500V	ELM	DM15C101K
C892	6.8mf	20%	35V	SP	1960685X0035FB

Symbol	Description			Mfr.	Part No.
C893	6.8mf	20%	35V	SP	1960685X0035FB
C900	25mf	LYTIC	16V	SP	3DD256G016BB4
C902	1mf	20%	35V	MAL	TDC105M035AL
C903	.01mf	20%	500V	SP	C023B501G103M
C950	7.5pf	10%	500V	ASP	9212-75910
C951	6.8mf	20%	35V	SP	1960685X0035FB
C952	1000pf	20%	500V	SP	C023B501F102M
C953	1mf	20%	35V	MAL	TDC105M035AL
C954	18pf	10%	500V	ELM	DM15C180K
C955	56pf	10%	500V	ELM	DM15C560K
C956	22mf	20%	100V	ERT	8131-100-651-224M
C957	200pf	10%	500V	ELM	DM15C271K
C958	33pf	5%	500V	ELM	DM15C330J
C959	1mf	LYTIC	50V	SP	30D105G050BA4
C960	6.8mf	20%	35V	SP	1960685X0035FB
C961	1mf	20%	35V	MAL	TDC105M035AL
C962	1mf	20%	35V	MAL	TDC105M035AL
C963	10pf	10%	500V	ASP	9213-10110
C964	100mf	LYTIC	10V	SP	C023B501E102M
C965	22mf	20%	100V	ERT	8131-100-651-224M
C981	39pf	1%	500V	ELM	DM15C390K
C982	15pf	5%	500V	ASP	9300-15110
C983	15pf	10%	500V	ASP	9300-15110

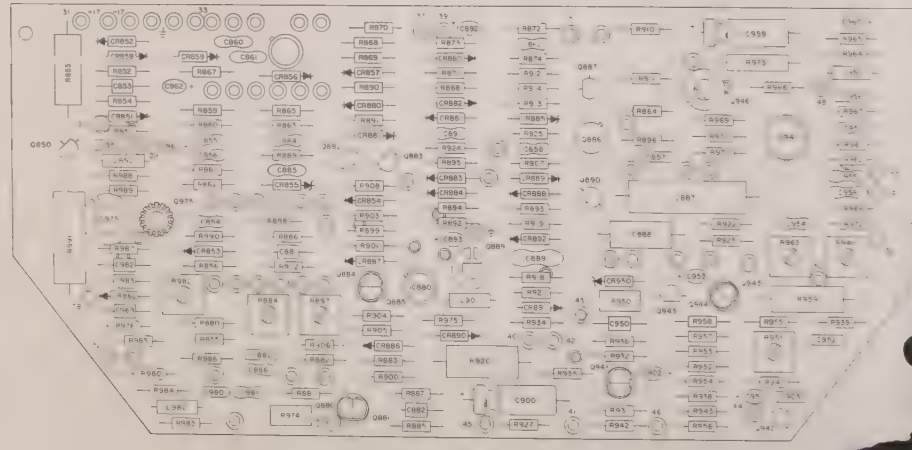
TRANSISTORS, DIODES & MISC.

Symbol	Description	Mfr.	Part No.
Q850	MPS6566	MOT	MPS6566
Q880	2N5225	MOT	2N5225
Q881	MPS6518	MOT	MPS6518
Q882	MPS6566	MOT	MPS6566
Q883	MPS3646	MOT	MPS3646
Q884	MPS6518	MOT	MPS6518
Q885	MPS6518	MOT	MPS6518
Q886	2N4340	SIL	2N4340
Q887	MPS6566	MOT	MPS6566
Q889	MPS6518	MOT	MPS6518
Q890	MPS6518	MOT	MPS6518
Q940	TIS97	TI	TIS97
Q941	MPS6518	MOT	MPS6518
Q942	TIS97	TI	TIS97
Q943	MPS6518	MOT	MPS6518
Q944	TIS97	TI	TIS97
Q945	TIS97	TI	TIS97
Q946	MPS6566	MOT	MPS6566
Q975	2N2905A	TI	2N2905A
IC850	MC802	MOT	MC802
IC880	MC802	MOT	MC802
IC940	MC1539G	MOT	MC1539G
IC975	MC1539G	MOT	MC1539G

Symbol	Description			Mfr.	Part No.
CR851	1N4149			APD	1N4149
CR852	1N4149			APD	1N4149
CR853	1N4149			APD	1N4149
CR854	1N4149			APD	1N4149
CR855	1N959B	ZENER		TR	1N959B
CR856	1N4149			APD	1N4149
CR857	1N4149			APD	1N4149
CR858	1N4149			APD	1N4149
CR859	1N4149			APD	1N4149
CR860	MZ2361			MOT	MZ2361
CR861	1N4149			APD	1N4149
CR862	1N4149			APD	1N4149
CR880	1N4149			APD	1N4149
CR881	1N965B	ZENER		TR	1N965B
CR882	1N4149			APD	1N4149
CR883	1N4149			APD	1N4149
CR884	1N4149			APD	1N4149
CR885	1N749A	ZENER		TR	1N749A
CR886	1N4149			APD	1N4149
CR887	1N4149			APD	1N4149
CR888	1N4149			APD	1N4149
CR889	1N4149			APD	1N4149
CR890	1N4149			APD	1N4149
CR891	1N4149			APD	1N4149
CR892	1N4149			APD	1N4149
CR950	1N961B	ZENER		TR	1N961B
L850	22uhy,	10%	.4W	DLV	1537-44
L901	1uhy	10%	.4W	DLV	BP774-2
L950	47uhy	10%	.4W	DLV	1537-60
S901	SWITCH, ROTARY			KH	B2987
S902	SWITCH, ROTARY			KH	B2993
S903	SWITCH, SLIDE			CW	GF326
S904	SWITCH, PUSH-BUTTON			CK	8221

MANUFACTURERS CODE

AB	(01121)	Allen Bradley Co.	Milwaukee, Wisc.
APD	(50273)	American Power Devices	Andover, Mass.
AS	( )	American Switch	Gloucester, Mass.
ASP	(82142)	Airco Speer	Dubois, Pa.
BKM	(30646)	Beckman Instr., Co.	Cedar Grove, N.J.
CW	(79727)	Continental Wirt Elec.	Philadelphia, Pa.
DLV	(99800)	Delevan Electronics	East Aurora, N.Y.
ELM	(72136)	Electromotive Mfg.	Willimantic, Conn.
ERT	(72982)	Erie Technological	Erie, Pa.
KH	(88865)	Krohn-Hite	Cambridge, Mass.
MAL	(37942)	P.R. Mallory & Co.	Indianapolis, Ind.
MOT	(04713)	Motorola Semiconductor	Phoenix, Ariz.
SIL	(17856)	Siliconix	Sunnyvale, Calif.
SP	(56289)	Sprague Electric Co.	North Adams, Mass.
TI	(01295)	Texas Instruments, Inc.	Dallas, Texas
TR	(03877)	Transitron Electric Co.	Wakefield, Mass.
TRW	(84411)	TRW Corp.	Ogallala, Neb.



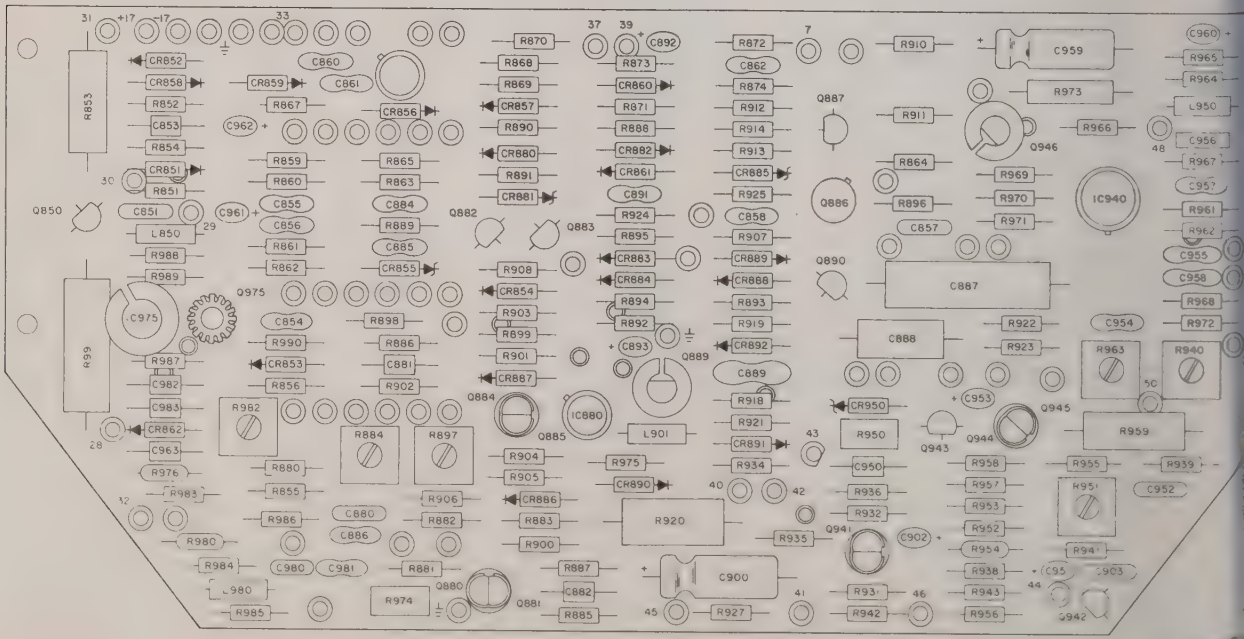
TRANSISTORS, DIODES & MISC.

Symbol	Description	Mfr.	Part No.
Q850	MPS6566	MOT	MPS6566
Q880	2N5225	MOT	2N5225
Q881	MPS6518	MOT	MPS6518
Q882	MPS6566	MOT	MPS6566
Q883	MPS3646	MOT	MPS3646
Q884	MPS6518	MOT	MPS6518
Q885	MPS6518	MOT	MPS6518
Q886	2N4340	SIL	2N4340
Q887	MPS6566	MOT	MPS6566
Q889	MPS6518	MOT	MPS6518
Q890	MPS6518	MOT	MPS6518
Q940	TIS97	TI	TIS97
Q941	MPS6518	MOT	MPS6518
Q942	TIS97	TI	TIS97
Q943	MPS6518	MOT	MPS6518
Q944	TIS97	TI	TIS97
Q945	TIS97	TI	TIS97
Q946	MPS6566	MOT	MPS6566
Q975	2N2905A	TI	2N2905A
IC850	MC802	MOT	MC802
IC880	MC802	MOT	MC802
IC940	MC1539G	MOT	MC1539G
IC975	MC1539G	MOT	MC1539G

Symbol	Description		Mfr.	Part No.
CR851	1N4149		APD	1N4149
CR852	1N4149		APD	1N4149
CR853	1N4149		APD	1N4149
CR854	1N4149		APD	1N4149
CR855	1N959B	ZENER	TR	1N959B
CR856	1N4149		APD	1N4149
CR857	1N4149		APD	1N4149
CR858	1N4149		APD	1N4149
CR859	1N4149		APD	1N4149
CR860	MZ2361		MOT	MZ2361
CR861	1N4149		APD	1N4149
CR862	1N4149		APD	1N4149
CR880	1N4149		APD	1N4149
CR881	1N965B	ZENER	TR	1N965B
CR882	1N4149		APD	1N4149
CR883	1N4149		APD	1N4149
CR884	1N4149		APD	1N4149
CR885	1N749A	ZENER	TR	1N749A
CR886	1N4149		APD	1N4149
CR887	1N4149		APD	1N4149
CR888	1N4149		APD	1N4149
CR889	1N4149		APD	1N4149
CR890	1N4149		APD	1N4149
CR891	1N4149		APD	1N4149
CR892	1N4149		APD	1N4149
CR950	1N961B	ZENER	TR	1N961B
L850	22uhy,	10% .4W	DLV	1537-44
L901	1uhy	10% .4W	DLV	BP774-2
L950	47uhy	10% .4W	DLV	1537-60
S901	SWITCH, ROTARY		KH	B2987
S902	SWITCH, ROTARY		KH	B2993
S903	SWITCH, SLIDE		CW	GF326
S904	SWITCH, PUSH-BUTTON		CK	8221

MANUFACTURERS CODE

AB	(01121)	Allen Bradley Co.	Milwaukee, Wisc.
APD	(50273)	American Power Devices	Andover,Mass.
AS	( )	American Switch	Gloucester,Mass.
ASP	(82142)	Airco Speer	Dubois, Pa.
BKM	(30646)	Beckman Instr., Co.	Cedar Grove, N.J.
CW	(79727)	Continental Wirt Elec.	Philadelphia, Pa.
DLV	(99800)	Delevan Electronics	East Aurora, N.Y.
ELM	(72136)	Electromotive Mfg.	Willimantic, Conn.
ERT	(72982)	Erie Technological	Erie, Pa.
KH	(88865)	Krohn-Hite	Cambridge, Mass.
MAL	(37942)	P.R. Mallory & Co.	Indianapolis, Ind.
MOT	(04713)	Motorola Semiconductor	Phoenix, Ariz.
SIL	(17856)	Siliconix	Sunnyvale, Calif.
SP	(56289)	Sprague Electric Co.	North Adams, Mass.
TI	(01295)	Texas Instruments, Inc.	Dallas, Texas
TR	(03877)	Transitron Electric Co.	Wakefield, Mass.
TRW	(84411)	TRW Corp.	Ogallala, Neb.



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